Valleylab™

Service Manual

CUSA EXcel™-8 System

Preface

This manual and the equipment it describes are for use only by qualified medical professionals trained in the particular technique and surgical procedure to be performed. It is intended as a guide for servicing the CUSA EXcel™ ultrasonic surgical aspirator only.

Equipment covered in this manual
CUSA EXcel™ ultrasonic surgical aspirator with 23 kHz and 36 kHz handpieces.

The ***CUSA EXcel ™System Service Manual*** consists of two parts—the text (part 1 of 2) and a *Schematics Supplement* (part 2 of 2), which contains the schematics.

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Patent Information

One or more of the following U.S. patents and corresponding foreign patents cover the CUSA EXcel system:

4734964	4768496	4827911	4921476	4931047
4988334	5015227	5190517	5421829	5466020
5484398	5847046	6214817	6256859	6499858

About This Manual

The service manual describes the CUSA EXcel ultrasonic surgical aspirator. It presents the CUSA EXcel as a system that includes a console, handpieces, and accessories:

- Descriptions of the system, its functions, specifications, and theory of operation
- Step-by-step instructions on how to unpack, install, maintain, calibrate, and troubleshoot the system
- Step-by-step instructions on how to replace specific components
- Parts lists, board layouts, and schematics.

Organization

We have organized this guide to introduce the safety issues, the system, and its functions. After safety and the system, the guide gives instructions for unpacking the system, then describes its components, technical specifications, and theory of operation. The next sections tell you how to check out, maintain, troubleshoot, replace parts, and calibrate the system. A schematics supplement includes printed circuit board (PCB) layouts and schematics.

Conventions Used in this Guide

Warning

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

Caution

Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

Notice

Indicates a hazard which may result in product damage.

▶ ***Important***

Indicates an operating tip or maintenance suggestion.

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Service Personnel Safety

In this section:

- Safety information
- Warnings, Cautions, and Notices, organized by section.

Safety Information

The safe and effective servicing of ultrasonic surgical equipment depends to a large degree on factors solely under the control of the service person. There is no substitute for a properly trained and vigilant service staff. It is important that you read, understand, and follow the procedures supplied with this ultrasonic equipment.

Warnings, Cautions, and Notices

Before servicing the CUSA EXcel console or handpieces, it is important that you read, understand, and follow the instructions and the warnings, cautions, and notices supplied with it. It is also important that you read, understand, and follow the instructions for any other equipment used to install, test, adjust, or repair the CUSA EXcel system.

General

Caution

Federal (USA) law restricts this device to sale by or on the order of a physician.

Notice

Operating the console outside the specified voltage ranges may cause damage to the power supply.

Introduction

Caution

Read all warnings, cautions, notices and instructions provided with the CUSA EXcel system before servicing it.

Read the instructions, warnings, cautions, and notices provided with the CUSA EXcel handpieces before servicing them.

To avoid injury to surgical personnel, keep fingers away from the suction pinch valve.

Unpacking and Installing the CUSA EXcel System

Caution

To prevent the ramp from falling and causing injury, be sure to hold the ramp in the up position while cutting the corrugated tab that secures it to the carton.

Notice

To avoid product damage, be sure to insert fuses that are appropriate to the power supply:

- 220 to 240 V – T5A, Time Delay (default)
- 95 to 120 V – T10A, Time Delay

Console Components

Caution

To avoid injury to surgical personnel, keep fingers away from the suction pinch valve.

Technical Specifications

Warning

Explosion Hazard Do not use the CUSA EXcel system in the presence of flammable anesthetics or any potentially explosive or flammable atmosphere.

Caution

To avoid injury to surgical personnel, keep fingers away from the suction pinch valve while powering the unit on or off, activating vibration, or using fast flush.

Checkout Procedures

Caution

Do not allow the handpiece tip to contact anyone or anything during tip activation. Contact may result in patient injury, user injury, or handpiece tip damage.

Notice

To avoid product damage, NEVER hold the handpiece in your hand while using the torque wrench to tighten or loosen the tip.

Maintaining the CUSA EXcel System

Warning

Electric Shock Hazard Always unplug the CUSA system before cleaning.

Notice

Do not rub, press, or touch any panels with solvents; caustic, corrosive, or abrasive cleaning or disinfectant compounds; or other materials that could scratch the panels. Do not use a betadine-based solution; it will cause discoloration.

Do not allow fluids to enter the chassis.

Do not clean the sterilizer case with abrasives. Product damage will result.

Product damage will result if you do not follow these notices when cleaning the handpiece:

- Do not immerse the handpiece cable electrical connector in liquid.
- Do not use ultrasonic or automated cleaners.
- Do not use chlorinated substances such as bleach solution.
- Do not clean the handpiece with abrasives such as Ajax, Comet, or steel wool.

Product damage will result if you do not follow these notices when cleaning the Tip Torquing Set.

- Do not use ultrasonic or automatic washers.
- Do not autoclave.
- Do not use chlorinated substances such as bleach solution.
- Do not clean with abrasives such as Ajax, Comet, or steel wool.

Troubleshooting

Warning

Electric Shock Hazard Do not touch any exposed wiring or conductive surface while the system is disassembled and energized. Never wear a grounding strap when working on an energized system.

Electric Shock Hazard Take appropriate precautions (such as the use of isolated tools and equipment; use of the "one hand rule," etc.) when taking measurements or troubleshooting the system.

Do not activate vibration or the CEM handswitching nosecone while using the tip cleaner. Tip damage, user injury, electrical shock, or any combination of these effects may occur.

Notice

Electrostatic Sensitive Devices This unit contains electrostatic sensitive components. When repairing the system, work at a static control workstation. Wear a grounding strap when handling electrostatic sensitive components. Handle circuit boards by their nonconductive edges. Use an antistatic container for transport of electrostatic sensitive components and circuit boards.

Replacement Procedures

Warning

Electric Shock Hazard Only trained biomedical engineers and technicians are authorized to service the CUSA EXcel system.

Electric Shock Hazard Do not touch any exposed wiring or conductive surface while the CUSA EXcel system is disassembled and energized. Never wear a grounding strap when working on an energized CUSA system.

Electric Shock Hazard Take appropriate precautions (such as the use of isolated tools and equipment; use of the "one hand rule," etc.) when taking measurements or troubleshooting the CUSA EXcel system.

High Current Hazard Do not touch the ultrasonics PCB heat sink while the CUSA EXcel system is energized. The heat sink is isolated from ground, and can deliver very high current, resulting in injury.

Notice

If you plan to connect the handpiece for activation, ensure that an I.V. set is available to supply cooling irrigation solution to the handpiece tip. Otherwise, damage to the tip and/or handpiece may result.

Electrostatic Sensitive Devices This unit contains electrostatic sensitive components. When repairing the system, work at a static control workstation. Wear a grounding strap when handling electrostatic sensitive components. Handle circuit boards by their nonconductive edges. Use an antistatic container for transport of electrostatic sensitive components and circuit boards.

When installing a new power supply, use the same screws and washers removed from the previous power supply. A too-long screw will damage the power supply.

To avoid product damage, do not remove the jumper cable or the connector at J4.

To avoid product damage, remove the ESD wrist strap before connecting cables to the Machine Control PCB.

To avoid product damage, when handling the suction pump controller card, do not turn the three white adjustment dials designated as current limit (R13), max speed (R12), and min speed (R11).

Calibration

Warning

High Current Hazard Do not touch the ultrasonics PCB heat sink while the CUSA EXcel system is energized. The heat sink is isolated from ground, and can deliver very high current, resulting in injury.

Repair Policy

Caution

To prevent the ramp from falling and causing injury, be sure to hold the ramp in the up position while stapling the corrugated tab that secures it to the crate.

Introduction

In this section:

- Overview
- Fragmentation
- Irrigation
- Aspiration (Suction)
- Handpieces
- Wide variety of tips.

For Your Information

Caution

Read all warnings, cautions, notices, and instructions provided with the CUSA EXcel system before servicing it.

Read the instructions, warnings, cautions, and notices provided with the CUSA EXcel handpieces before servicing them.

This section presents the CUSA EXcel system general information; what it is, what it does, and (generally) how it works.

Overview

The CUSA EXcel system is an ultrasonic surgical aspirator that allows a surgeon to remove tissue—selectively and with precise control—from the body. It performs three functions:

- Fragmentation
- Irrigation
- Aspiration (suction).

All three functions may occur at the same time.

The CUSA EXcel system includes the following components:

- The console:
  - The console body houses electronics, pumps, and other parts that make the system work.
  - The control panel allows the user to control the system.
- The handpiece is the handheld surgical device that actually touches the patient.
- Accessories include a variety of items; for example, manifold tubing, a large selection of tips, a tip torquing base and torque wrench, and a sterilizer case.

Fragmentation

Tip Motion

Fragmentation occurs when the vibrating tip interacts with tissue. As the tip begins to move toward tissue, it accelerates, impacts the tissue, then penetrates the tissue. The acceleration, impact, and penetration produce a combination of direct mechanical forces and hydrodynamic pressures that burst cells.

For more information on how the handpiece works, refer to Section 6, *Principles of Operation*, in this manual.

Cooling

The high frequency vibration generates heat. To reduce the heat, the CUSA EXcel system includes a closed, recirculating cooling water system. This system pulls water from a cooling water reservoir, through a tube in the handpiece cable, through the handpiece, and through a return tube in the handpiece cable to the cooling water reservoir. Cooling water flows at 35 to 50 cc/min.

As it passes through the handpiece, the water removes heat.Normal handpiece temperature, in sustained heavy use, remains at about 40° C.

Use distilled water for the cooling water system because it does not contain natural minerals, chemical additives, or organic materials that are present in tap water. Any of these impurities in tap water can cause problems within the cooling water system.

Irrigation

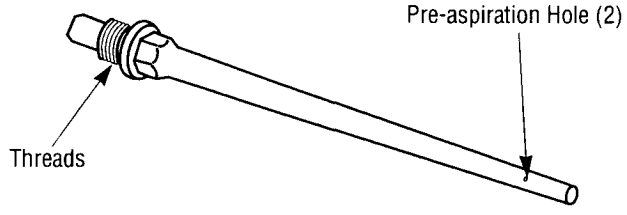
Sterile irrigation fluid flows from an I.V. set (bottle or bag and I.V. administration tubing) to a variable speed peristaltic pump:

- The pump moves fluid at 1 to 10 cc/min; default flow is 3 cc/min. Adjustment buttons (blue up/down arrows on black buttons at the bottom of the irrigation display column on the control panel) allow you to increase or decrease the irrigation flow.
- The pump can also accelerate to a Fast Flush speed, pumping at 25 to 30 cc/min. The Fast Flush pedal on the CUSA EXcel system footswitch activates the Fast Flush feature.

The pump pushes the fluid through the manifold irrigation tubing to a flue, a sleeve surrounding the vibrating tip. As the irrigation fluid passes through the flue, it cools the tip.

When the fluid reaches the distal end of the tip, as much as 99% of it passes through two pre-aspiration holes in the tip, eliminating fluid pooling on the sterile field and continually clearing the suction system. The fluid that does not pass through the pre-aspiration holes irrigates the surgical site and suspends fragmented tissue.

Figure 2-1.
The pre-aspiration holes and threads on tips



Aspiration (Suction)

A vacuum pump in the console body provides up to 660 mm mercury maximum vacuum at sea level. Adjustment buttons (green up/down arrows on black buttons at the bottom of the aspiration display column on the control panel) allow you to increase or decrease the suction from 10 to 100% in 10% increments.

The suction, which produces an air stream moving toward the vacuum pump, pulls irrigation fluid, fragmented tissue, and other materials through the distal end of the surgical tip. From the tip, the aspirated materials pass through the manifold suction tubing into the suction canister. From the suction canister, the air stream continues to flow through a contamination guard that filters any remaining particulate matter or moisture, preventing them from entering the vacuum pump.

A suction pinch valve on the front of the console opens when the system is on and closes to stop suction in the following cases:

- When priming the irrigation system
- When pressing the Fast Flush pedal
- In Run Status, when you release the Vibration pedal. In this case, the pinch valve closes for about one second, then re-opens.
- In Lap Mode, when you release the Vibration pedal. This suction stoppage prevents depletion of the pneumoperitoneum.

Caution

To avoid injury to surgical personnel, keep fingers away from the suction pinch valve.

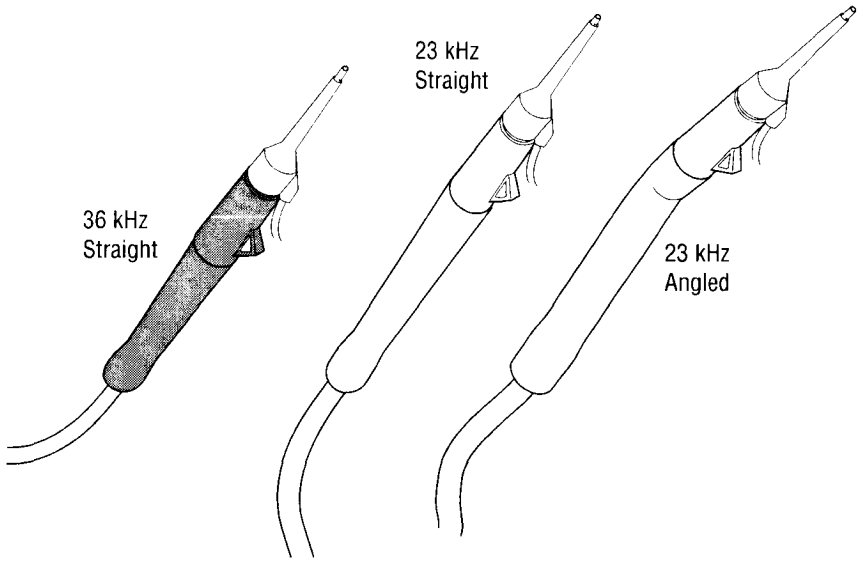
When the System Power Switch is off, the suction pump remains off and the suction pinch valve remains closed. A button on the front of the suction pinch valve allows you to open the valve manually.

Handpieces

The CUSA EXcel system includes three handpiece configurations:

- 36 kHz, straight (smaller handpiece, black body, blue connector)
- 23 kHz, straight (gray body, green connector)
- 23 kHz, angled (gray body, green connector)

Figure 2-2.
The three handpieces in the CUSA EXcel system



Wide Variety of Tips

You can use a wide variety of tips with the CUSA EXcel handpieces. Tips vary in inside diameter, length, and shape (straight or curved). For complete information on the tips that are available for each handpiece, refer to Appendix B, *Accessories*, in the ***CUSA EXcel System User's Guide*** .

Unpacking and Installing the CUSA EXcel System

In this section:

- The responsibility of the manufacturer
- Unpacking the CUSA EXcel system
- Preparing the CUSA EXcel console for use:
  - Replacing the power connector
  - Replacing fuses (if necessary)
  - Replacing a Control Panel overlay (optional)
  - Installing the reference card set.

The Responsibility of the Manufacturer

Valleylab is responsible for the safety, reliability, and performance of the CUSA EXcel system only under the following circumstances:

- The person unpacking and installing the unit follows the installation and setup procedures in this manual.
- Authorized persons perform assembly operations, re-adjustments, modifications, or repairs.
- The electrical installation of the relevant room complies with local codes and regulatory requirements.
- You use the equipment in accordance with the Valleylab instructions for use.

For warranty information, refer to the *Preface* section of this manual.

Unpacking the CUSA EXcel System

The CUSA EXcel system arrives in a corrugated cardboard crate strapped to a wood shipping pallet. The corrugated cardboard crate has several components:

- A bottom, larger section contains the CUSA EXcel console and foam packing cushions.
- A tray, inserted into the top of the crate and supported by the top of the crate walls, contains the footswitch, contamination guards (2), service manual, inservice kit, and dust cover.
- A lid covers the crate/tray assembly.

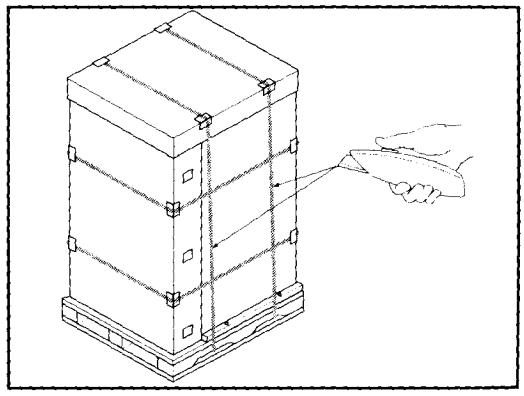
Tools You Will Need

- Utility knife
- Pliers (optional).

Unpacking Procedure

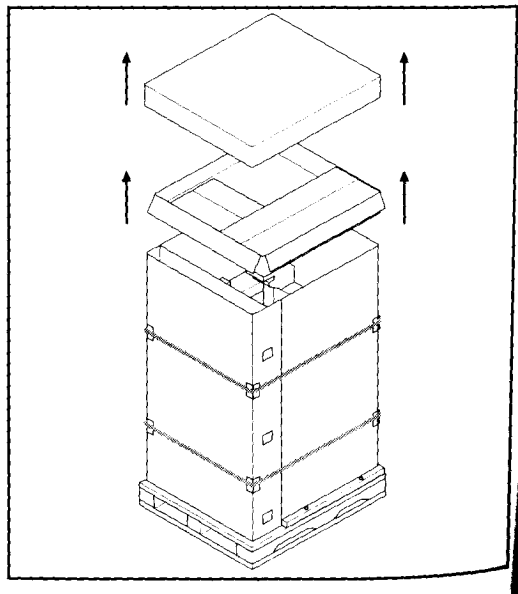
1. Cut the vertical bands on the shipping crate. Remove the bands.

   Note: Save the box edge protectors for use when shipping the system.



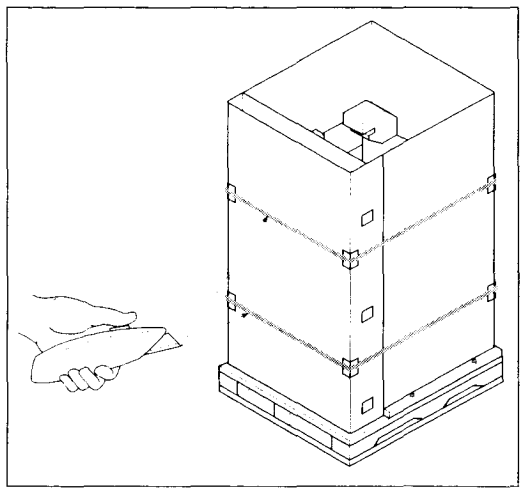
2. Lift the lid and the tray from the crate.

   Remove the contents from the tray, then put the tray aside.



3. Cut and remove the horizontal bands on the crate.

   Note: Save the box edge protectors for use when shipping the system.



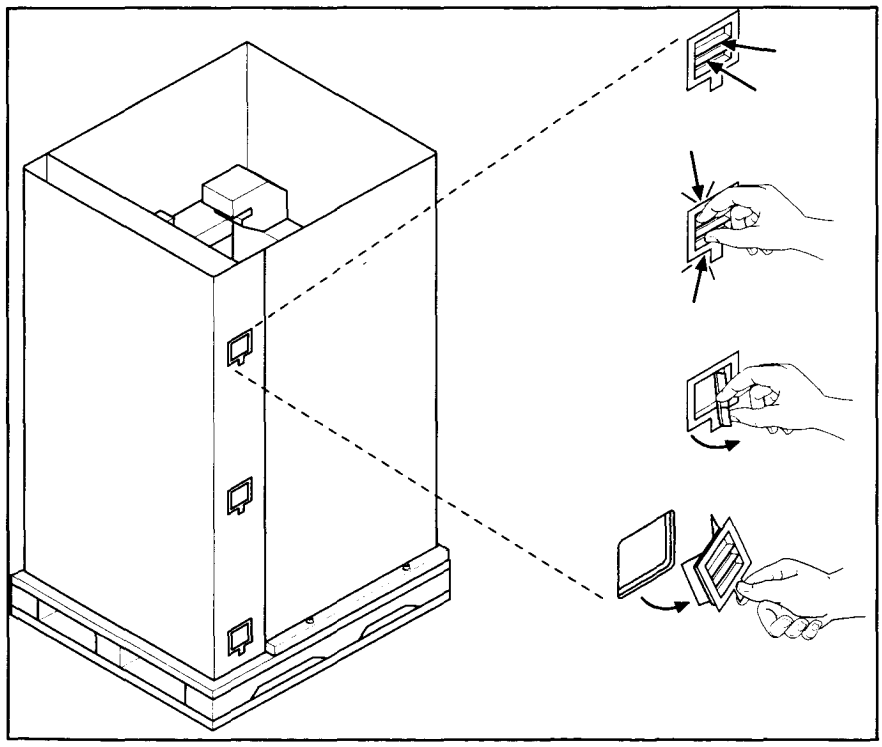
4. Remove the three plastic clips that hold the crate closed. (If the clip is especially tight, you may need to use pliers for this step.) Refer to the following figure.

   a. Inside the clip, grasp the two horizontal bars near the locking retainer (on the right side of the clip).

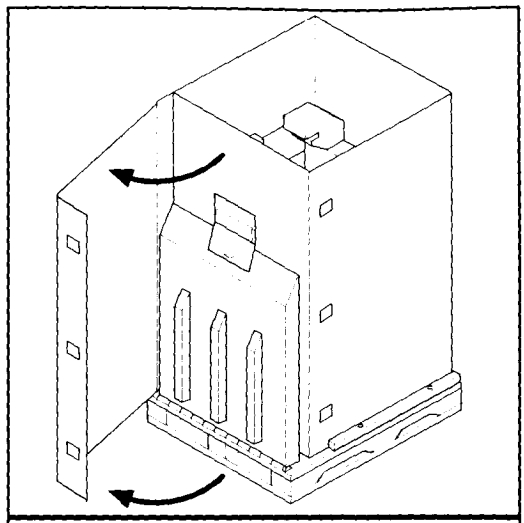
   b. Squeeze the bars toward each other to release them from the locking retainer.

   c. Pull the bars toward you. They should swing outward.

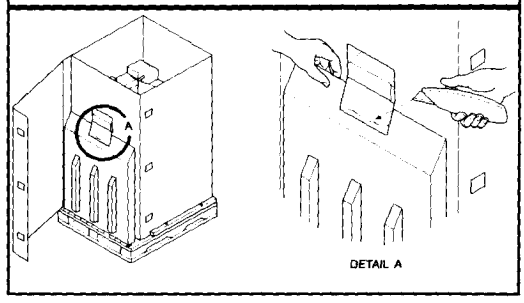
   d. Pull the tab at the bottom of the clip to remove the clip from the carton.



5. Open the crate.



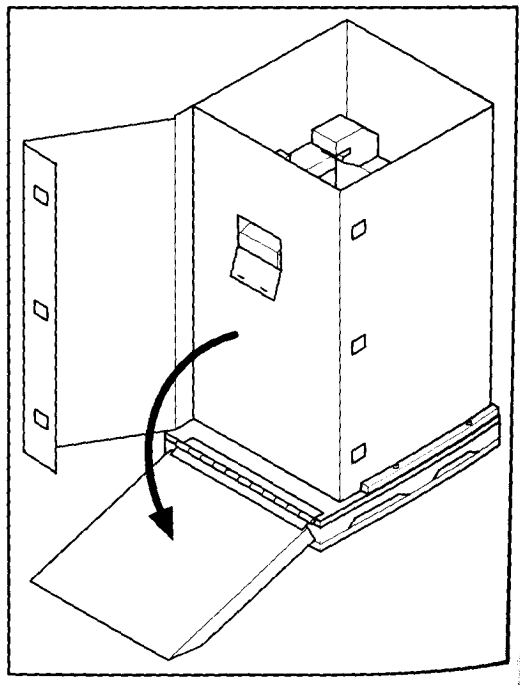
6. Cut the corrugated tab that secures the ramp to the carton. Cut as close as possible to the staples that hold the tab to the ramp; you may want to use the tab again.



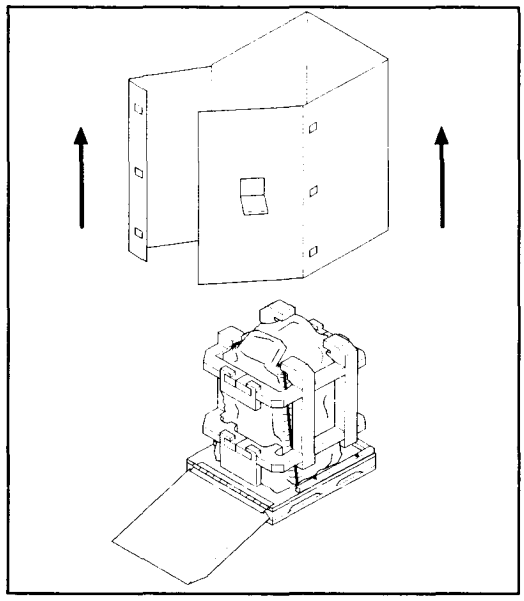
Caution

To prevent the ramp from falling and causing injury, be sure to hold the ramp in the up position while cutting the corrugated tab that secures it to the carton.

7. Lower the ramp.

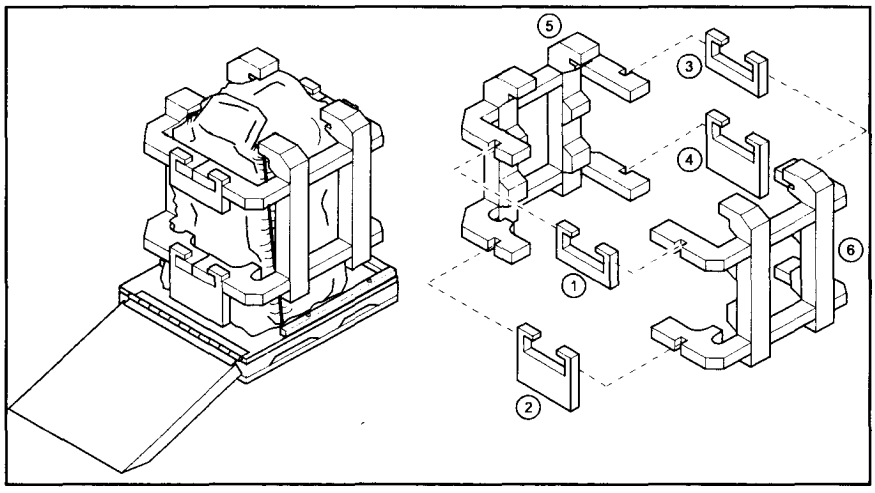


8. Lift the corrugated carton walls off the pallet.

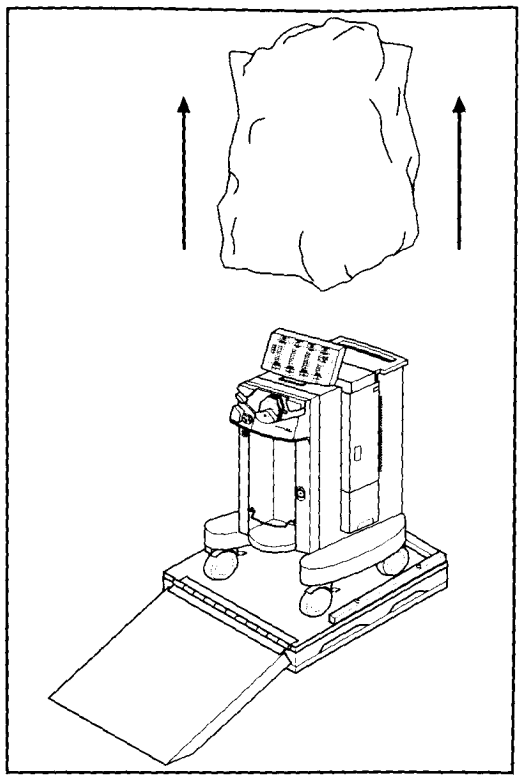


9. Remove the four interlocking foam pieces from the foam cushion around the console (refer to the following figure).

   Remove the right and left foam cushions from the console.



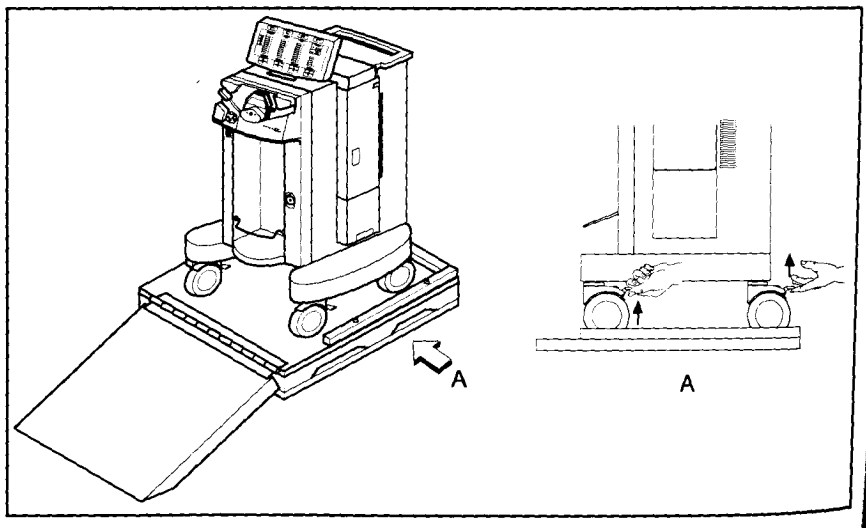
10. Cut the vertical band on the clear plastic bag, then remove the bag from the console.



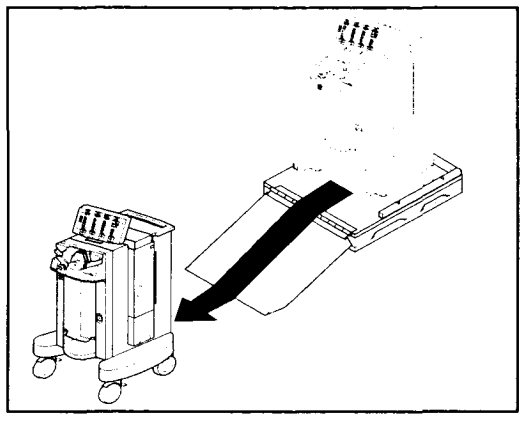
11. The rear casters have direction locks that keep the wheels rolling in one direction; the front casters have brake locks that, when locked, prevent the wheels from rolling (refer to the following figure).

a. Unlock the front casters by lifting the lock lever upward.

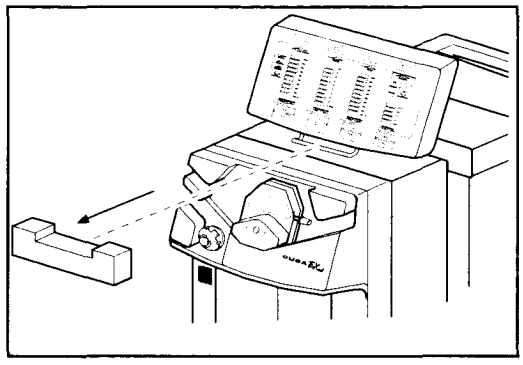
b. Check the rear casters to be sure that, if locked, they will allow the console to roll toward the ramp.



12. Roll the console down the ramp. If the rear casters are unlocked, be sure that you do not allow the console to roll off the side of the ramp.



13. Unlock the control arm release tab, then remove the U-shaped foam cushion from under the control panel.



Put the box edge protectors and all foam packing materials into the clear plastic bag for storage. Save all shipping components. You will need them if you need to return the console to Valleylab. In fact, it is very important that you use the proper materials and the proper packing procedures to ship the console. If, in Valleylab's judgement, you fail to use the proper packing procedures or if you use improper packaging materials to return the console, you may void the warranty on this system. For more information on packing the console for shipping, refer to Section 13, *Repair Policy,* in this guide.

Inspect all contents for damage that may have occurred during shipping. If any damage has occurred, notify Valleylab immediately to arrange repair or replacement of damaged parts. For more information on how to arrange repair or replacement, refer to Section 13, *Repair Policy.*

If you have any questions about the contents of these cartons, contact the Valleylab Service Center nearest you, or your Valleylab representative.

Preparing the CUSA EXcel Console for Use

Valleylab ships the CUSA EXcel system in two boxes. The large box contains the following items:

- Console
- Footswitch
- In-service kit
- Contamination guard
- Service manual
- Dust cover.

The small box contains several other items:

- User's guides
- Reference card set
- Instructions for installing reference card set in the console control panel
- Tip card.

On the CUSA EXcel console, Valleylab provides the following items:

- Common European power connector
- 220 to 240V, T5A, time delay fuses
- International (symbols only) control panel overlay – installed.

Before shipping, Valleylab includes, but does not install, a reference card set.

If your facility uses a different power connector or receives 95 to 120 V power, you need to make the appropriate changes to the system:

- Replace the power connector.
- Change the fuses.

If your facility has ordered an English language kit, replace the international control panel overlay and reference card set.

Replacing the Power Connector

If your facility's power receptacles are not compatible with the standard connector supplied on the CUSA EXcel system, install a different power connector according to your institution's policy.

Tools needed:

Slotted blade screwdriver

Procedure:

1. Remove the connector provided with the unit.
2. Attach the new connector, using the following chart:

Table 3-1.
Wire colors

Wire Color	Prong
green with yellow stripe	safety ground
brown	line/hot
light blue	neutral

▶ ***Important***

Ensure that all electrical installations comply with local codes and regulatory requirements.

The power connector meets all requirements for safe grounding. Do not defeat its purpose by using extension cords or three-prong-to-two-prong adapters. Periodically check the power cord for damaged insulation or connectors. Always grasp cords by the connector; do not pull on the cord to remove the connector from the wall receptacle.

If required by local regulations, connect an equipotential grounding cable to the equipotential grounding lug on the rear of the CUSA EXcel console.

Replacing Fuses (If Necessary)

Notice

To avoid product damage, be sure to insert fuses that are appropriate to the power supply:

- 220 to 240 V – T5A, Time Delay (default)
- 95 to 120 V – T10A, Time Delay

You must change the fuses (located on the rear panel) if either of the following situations occur:

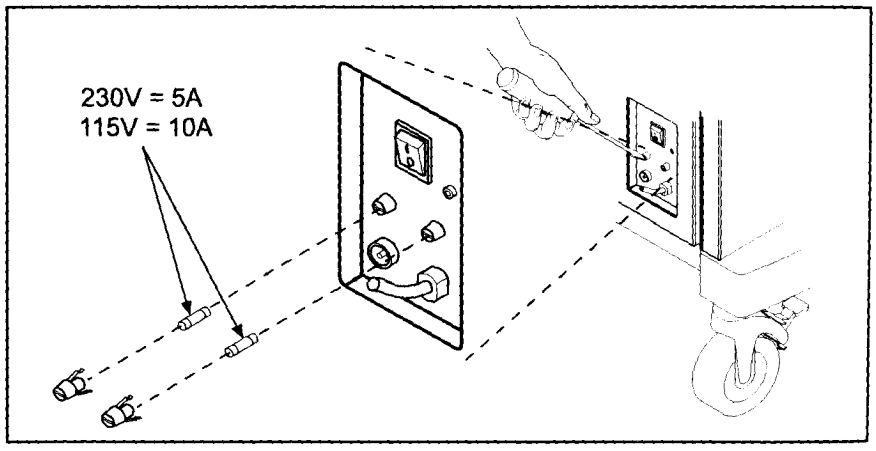
- A fuse burns out.
- Your facility receives 95 to 120 V power.

Tools needed: Small flat-headed screwdriver

Procedure (refer to Figure 3-2):

1. Using the screwdriver, turn the fuse cover counterclockwise (about 45°). The fuse holder pops loose.

Figure 3-1. *Replacing fuses*



2. Remove the fuse holder from the rear panel.
3. Replace the fuse:

Table 3-2. *Fuse values*

Volts	Amps	Type
220 to 240 V	T5A	Time Delay (default)
95 to 120 V	T10A	Time Delay

4. Insert the holder, and turn the fuse cover clockwise.

Replacing a Control Panel Overlay (Optional)

On the control panel, an overlay identifies buttons and indicators. For shipments outside the United States, Valleylab provides an international overlay on which symbols identify the control panel features. However, Valleylab also makes an English language kit available part of which is an overlay showing English language words rather than international symbols. If your facility has purchased the English language kit, the person who unpacks the CUSA EXcel system and prepares it for use must replace the international overlay with the English language overlay.

Tools needed:

- Small pliers
- Phillips screwdriver.

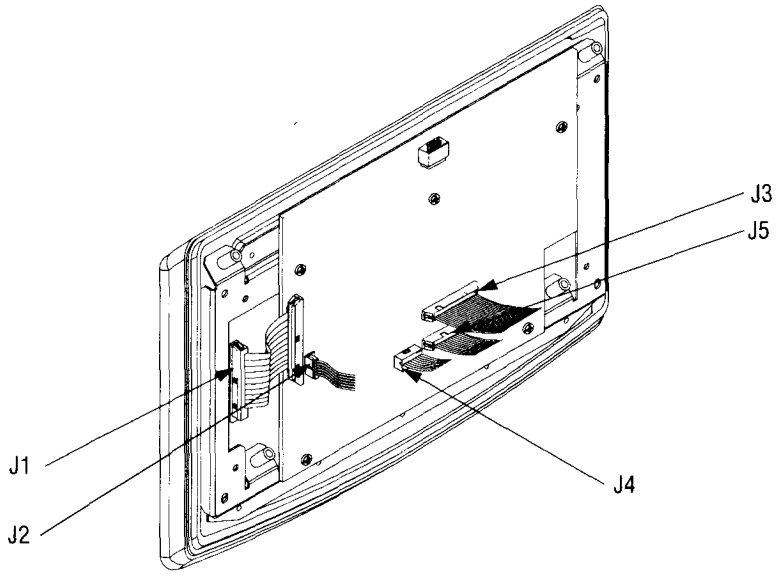
Remove the Control Panel Assembly

1. Swivel the control head so that the front of the control panel is 90° from the front of the console.
2. Remove four screws (M4 Phillips) and four lock washers (M4), located at the rear of the control head, that fasten the control panel assembly to the control head.

▶ ***Important***
When the screws are loose, take care not to let the control panel assembly fall out of the control head.

3. Slide the control panel forward far enough to allow disconnecting the following cables:
   - 40 pin ribbon cable (J3)
   - 20 pin ribbon cable (J5)
   - 10 pin cable (J4)
   - 6 pin cable (J2).

Figure 3-2.
Disconnecting control panel assembly cables



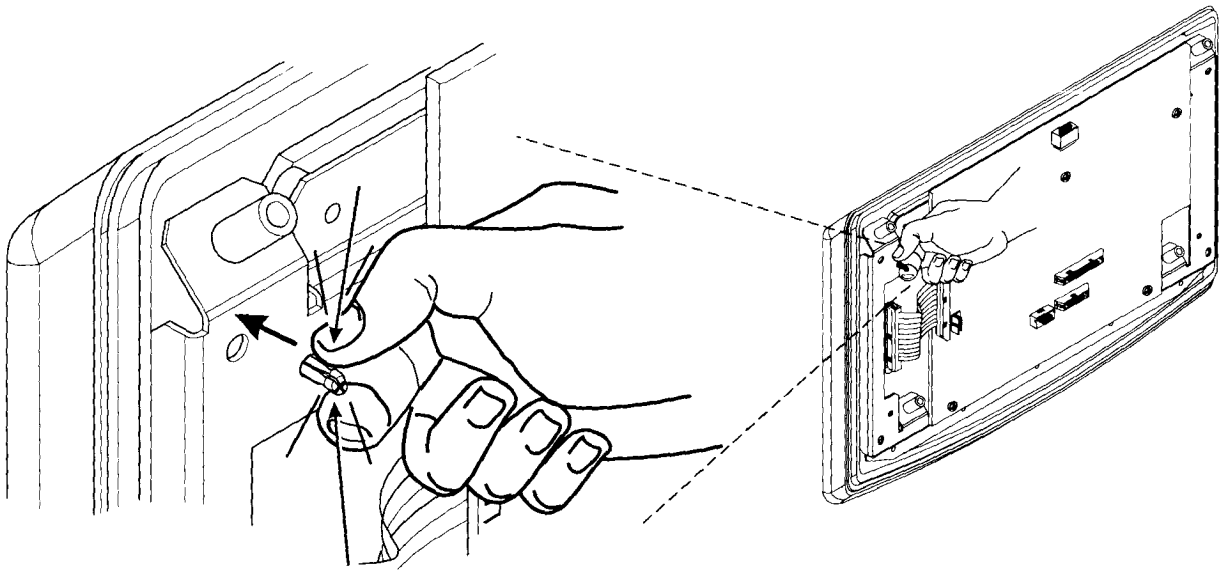
4. Remove the control panel assembly from the control head.

Remove the Control Panel Overlay

Four snap-in standoffs fasten the overlay to the control panel assembly.

1. Attach an ESD strap.
2. With your fingertips or small pliers, squeeze the spring-loaded flanges on the standoffs to retract them.
3. With the flanges retracted, push the standoffs out of the control panel assembly to release the overlay.

Figure 3-3.
Removing the control panel overlay



Install the Control Panel Assembly

1. Remove ESD strap.

Notice

To avoid product damage, remove the ESD wrist strap before connecting cables to the Machine Control PCB.

2. Position the control panel assembly at the control head opening.
3. Before sliding the control panel assembly into the control head, connect the following cables (Refer to Figure 3-2):
   - 40 pin ribbon cable (J3)
   - 20 pin ribbon cable (J5)
   - 10 pin cable (J4)
   - 6 pin cable (J2).
4. Slide the control panel assembly into the control head.
5. Replace four screws (M4 Phillips) and four lock washers (M4), located at the rear of the control head, that fasten the control panel assembly to the control head.

▶ ***Important***

While the screws are still loose, take care not to let the control panel assembly fall out of the control head.

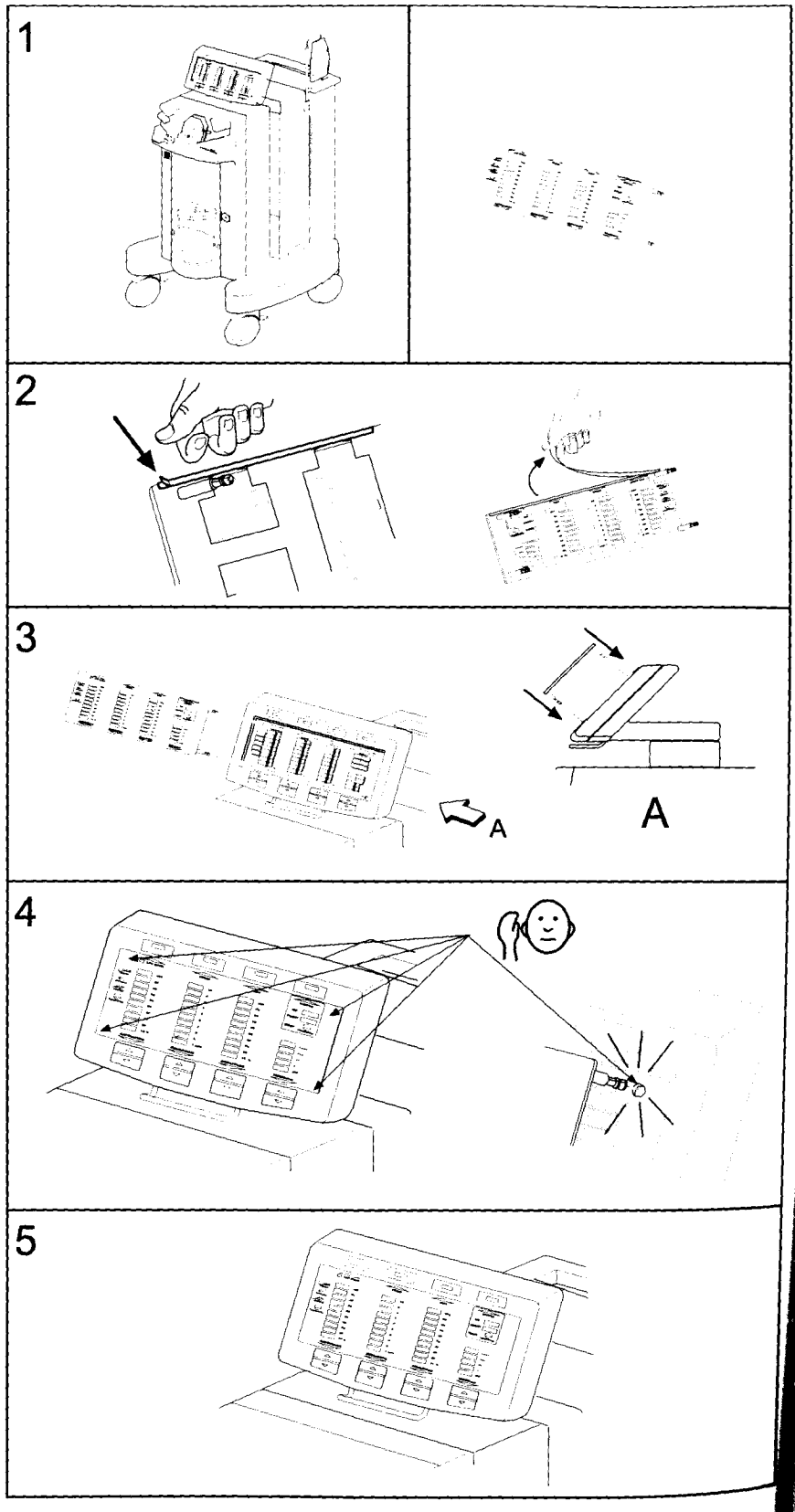
6. Swivel the control head so that the front of the control panel aligns with the front of the console.

Install the Control Panel Overlay

Refer to Figure 3-5.

1. Identify the overlay to be used.
2. Remove the protective tape from the overlay edges.
3. Position it correctly on the control panel.
4. When the tips of the standoffs rest in the corresponding holes in the control panel, push on the standoffs with your thumbs until you feel and hear them snap into place.
5. Plug the power cord connector into the wall receptacle.
6. Turn on the AC Main Switch, located on the rear panel.

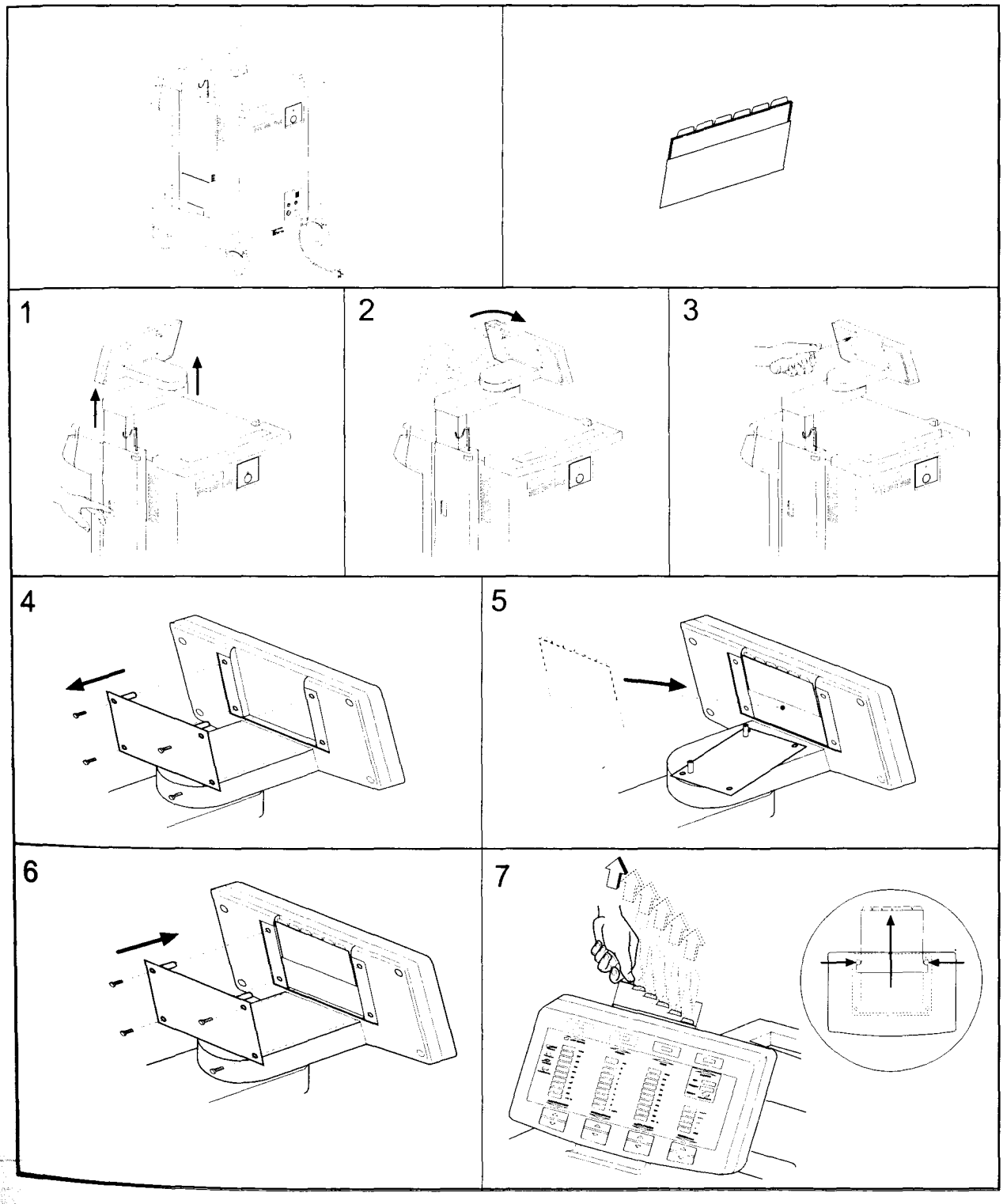
Figure 3-4.
Installing the control panel overlay



Installing the Reference Card Set

You need to install the reference card set into the rear of the control panel. Refer to Figure 3-6 for instructions.

Figure 3-5.
Installing the reference cards



Console Components

In this section:

- Console overview and structural features
- Control panel
- Console body front panel
- Console body side panel
- Console body rear panel
- Symbols on the control panel
- Other features.

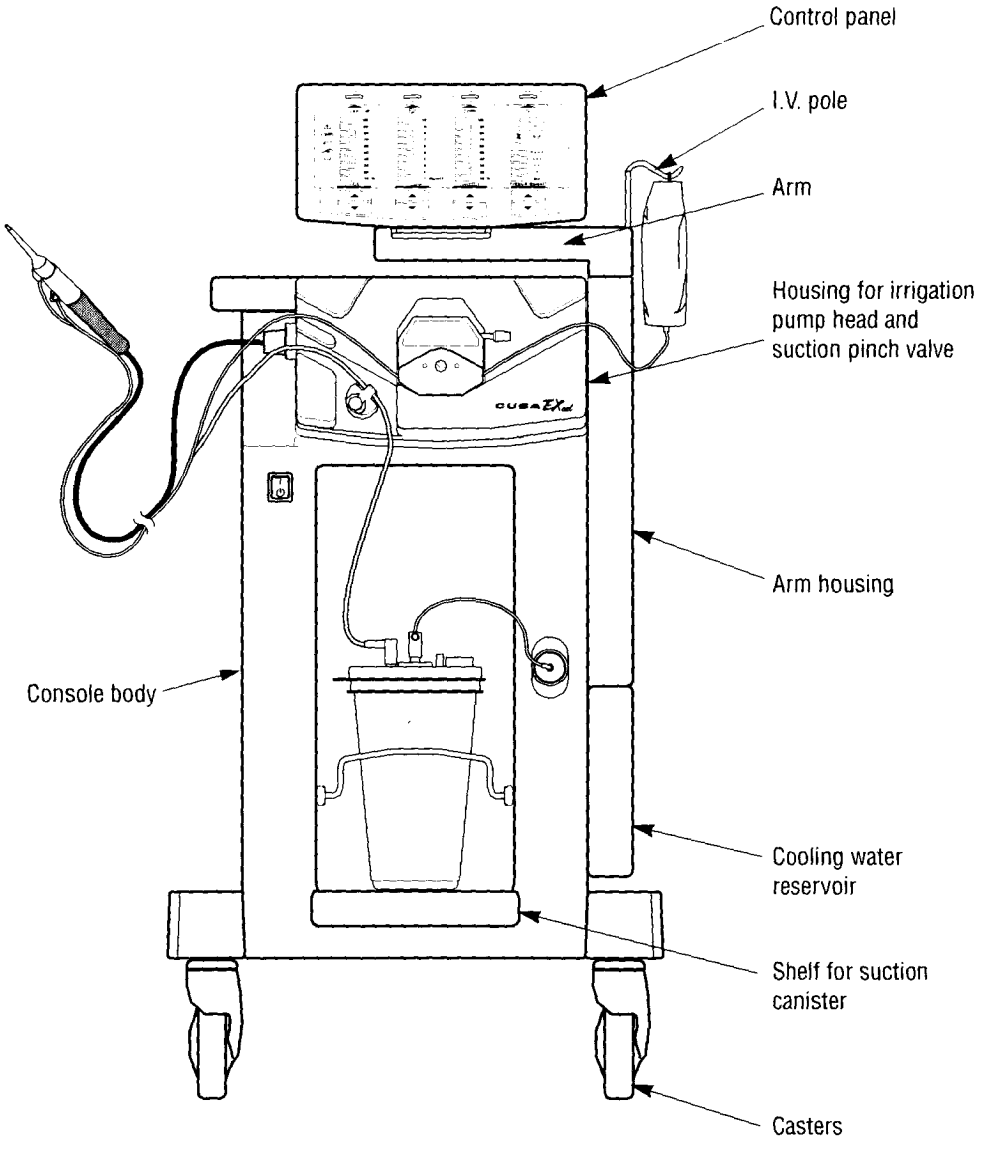
For Your Information

This section presents the CUSA EXcel console. It begins with an overview of the console, then describes each major console subsystem and its components. The description includes an illustration and a brief sketch of the function each subsystem or component serves.

Console Overview and Structural Features

This drawing presents the front view of the CUSA EXcel console, with structural features called out.

Figure 4-1.
Console structural features



I.V. Pole

Attached to the right side of the console, it supports the sterile irrigation fluid container. You can raise or lower the pole; you can also rotate the pole 90° in the lower position.

Control Panel

Mounted on the arm, the control panel allows the user to control all system functions. The next page presents control panel details.

Arm and Arm Housing

- Supports the control panel.
- Allows the control panel to pivot 135° to allow users to see the control panel from most of the operating room.
- Adjustable—lifts to allow a CUSA Electrosurgical Module (CEM) generator to sit on top of the console body, under the control panel.

The **Arm Housing** covers the arm attachment along the console body side panel.

Housing for Irrigation Pump Head and Suction Pinch Valve

The prominent black area at the top of the console body includes the following features:

- The irrigation pump head and irrigation tube pathway (marked with blue lines)
- The suction pinch valve and suction tube pathway (marked with a light green line).

Console Body

The main body of the console unit contains the electronics, pumps, and other working components. A later page presents console body details.

Shelf for Suction Canister

The shelf provides a place to put the hospital provided suction canister.

Casters

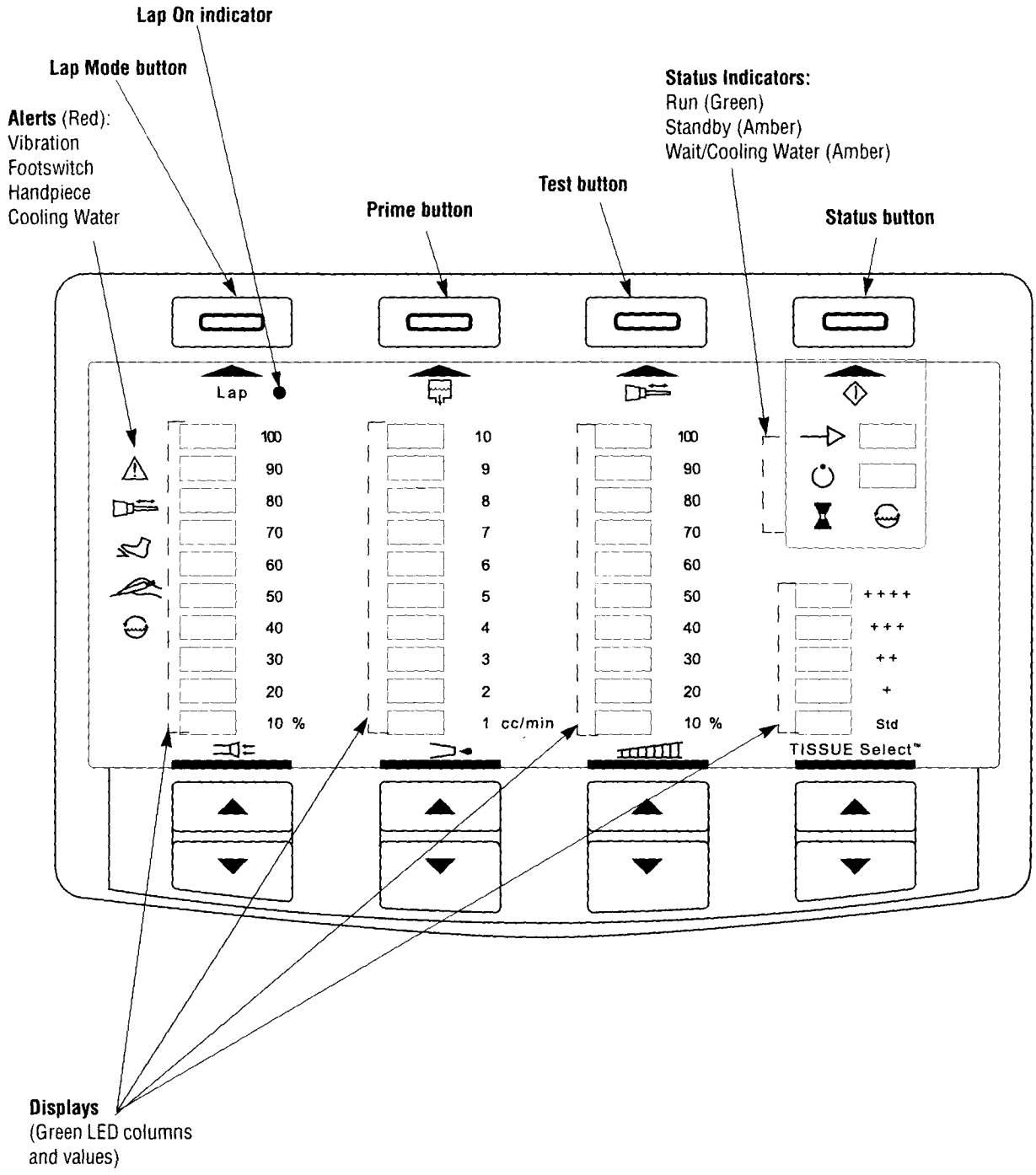
Unlocked, both front and rear casters roll easily and rotate freely.

- Front casters have brake locks that stop the wheels from rolling.
- Rear casters have direction locks; when locked, casters remain fixed in one direction.

Control Panel

A slot in the rear of the control panel allows you to store the quick reference guide.

Figure 4-2.
Control panel features



Alerts

All alerts are red. When lit, the alerts indicate the following:

Alert: An alert condition exists.

Vibration: Amplitude is out of range.

Footswitch: Connector not plugged into its receptacle on the console rear panel.

Handpiece: Connector not plugged into its receptacle on the console.

Cooling Water: Cooling water problem in the system.

Lap Mode, Prime, Test, and Status Buttons

To activate Lap Mode, Prime, or Status, press the button once; to deactivate the function, press the button again. To activate Test, press the button once; it automatically deactivates when the test is complete.

Lap Mode: Selects the Laparoscopic mode of operation—the system provides no suction to the handpiece until you activate the Vibration pedal.

When you activate the Lap Mode, the system turns on the Lap On indicator light.

Prime: Automatically increases irrigation rate to 25 to 30 cc/min to pump irrigation fluid to the tip. A timer turns Prime off after approximately one minute.

Test: Verifies the handpiece is working properly by automatically increasing tip amplitude to 100%, then decreasing it to 0%—all within 4 seconds.

Status: Toggles the status between Standby and Run.

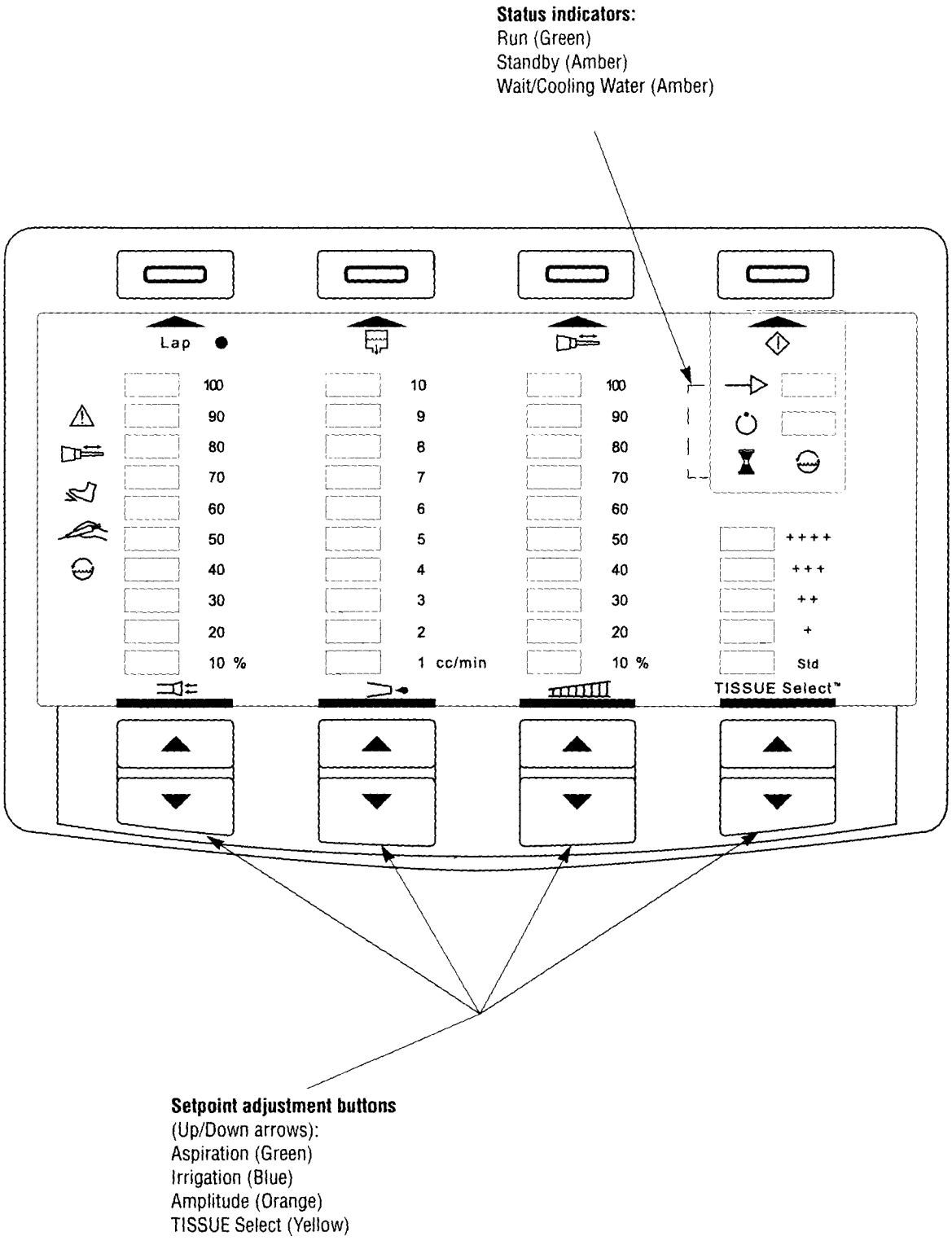
Displays

Green light emitting diodes (LEDs) show user adjusted setpoints for Aspiration, Irrigation, and Amplitude:

- Not Activated: One LED illuminates to show the setpoint value
- Activated: All LEDs up to and including the setpoint value light up.

For TISSUE Select, "Std" (standard) is the first setpoint value; "++++" is the highest setpoint value.

Figure 4-3.
Control panel features (continued)



Status Indicators

To change from Standby to Run, or from Run to Standby, press the Status button.

Run: A green LED illuminates to show when the system is in Run status.

Standby: An amber LED illuminates to show when the system is in Standby status.

Wait: An amber LED illuminates in the following circumstances:

- Flashing – Immediately after turning on (|) the System Power Switch, the system automatically fills the handpiece with cooling water
- Flashing – Immediately after turning off (⏻) the System Power Switch, the system automatically drains handpiece cooling water
- Continuous – When any alarm condition exists
- Continuous – When in Prime mode.

Cooling Water: An amber LED illuminates in the following circumstances:

- Immediately after turning on (|) the System Power Switch, the system automatically fills the handpiece with cooling water.
- Immediately after turning off (⏻) the System Power Switch, the system automatically drains handpiece cooling water.

Setpoint Adjustment Buttons

Marked with Up/Down arrows, these buttons allow you to adjust the setpoint values:

Aspiration (Suction): 10 increments; linear scale of 10 to 100%; default value is 100%.

Irrigation: 10 increments; linear scale of 1 to 10 cc/min; default value is 3 cc/min.

Amplitude: 10 increments; linear scale of 10 to 100%; default value is 10%.

TISSUE Select: 5 increments from std (standard operation) to ++++. TISSUE Select interrupts continuous vibration for specified times:

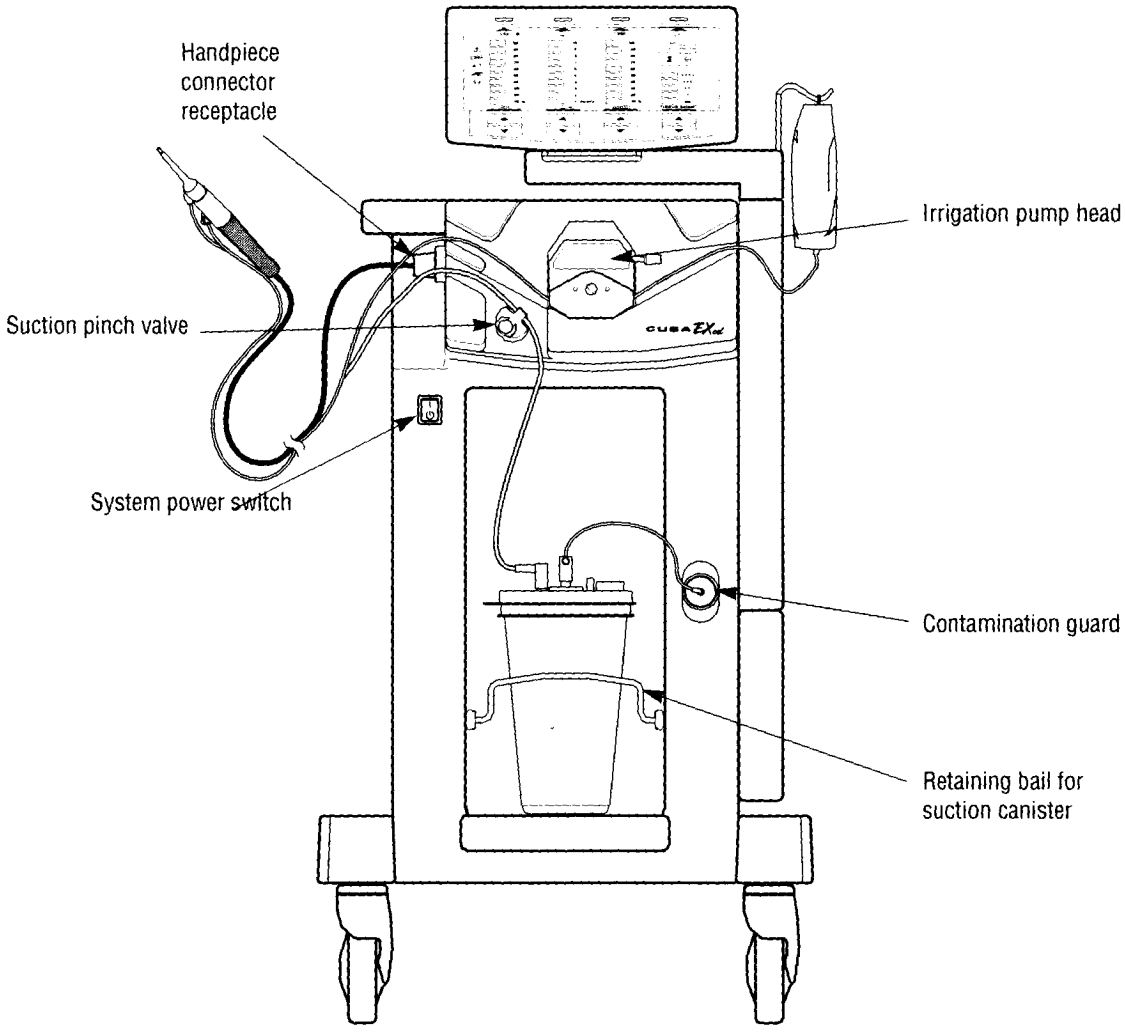
Setting	On-Time	Off-Time
Std	continuous	0 ms*
+	40 ms	10 ms
++	30 ms	10 ms
+++	20 ms	10 ms
++++	10 ms	10 ms

**1 ms = 1 millisecond = 1 one-thousandth of a second*

Push a button once for a single change in setpoint value. Holding down the button changes a setpoint value by only one setting (you get no additional setpoint value changes by holding down the button).

Console Body Front Panel

Figure 4-4.
Console body—front view



Handpiece Connector Receptacle

This receptacle allows you to connect the handpiece to the console. It is o
the left side (as you face the front panel) of the console.

Suction Pinch Valve

Caution

To avoid injury to surgical personnel, keep fingers away from the suction pinch valve.

When closed, the valve pinches off suction flow to the handpiece:

- When priming the irrigation system
- When pressing the Fast Flush pedal
- In Run Status, when you release the Vibration pedal. In this case, the pinch valve closes for about one second, then re-opens.
- In Lap Mode, when you release the Vibration pedal. This suction stoppage prevents depletion of the pneumoperitoneum.

The suction pinch valve default position (system off) is closed. If the System has been running, when you turn the Power Switch off, the suction pinch valve remains open until the drain cycle has finished, then closes. A button on the front of the suction pinch valve allows you to open the valve manually.

System Power Switch

Turning this switch on (|) activates all system components and begins filling the handpiece with cooling water. Turning this switch off (⏻) activates the cooling water drain cycle. When the system has drained water from the cooling water system (about one minute), it automatically deactivates all system components.

Irrigation Pump Head

A latch rotates from right to left to open the pump head, and from left to right to close. When open, it allows you to place irrigation tubing into the peristaltic pump. Closed, the pump head holds irrigation tubing against the peristaltic pump.

Contamination Guard

▶ ***Important***
The guard is hydrophilic and becomes blocked when wet.

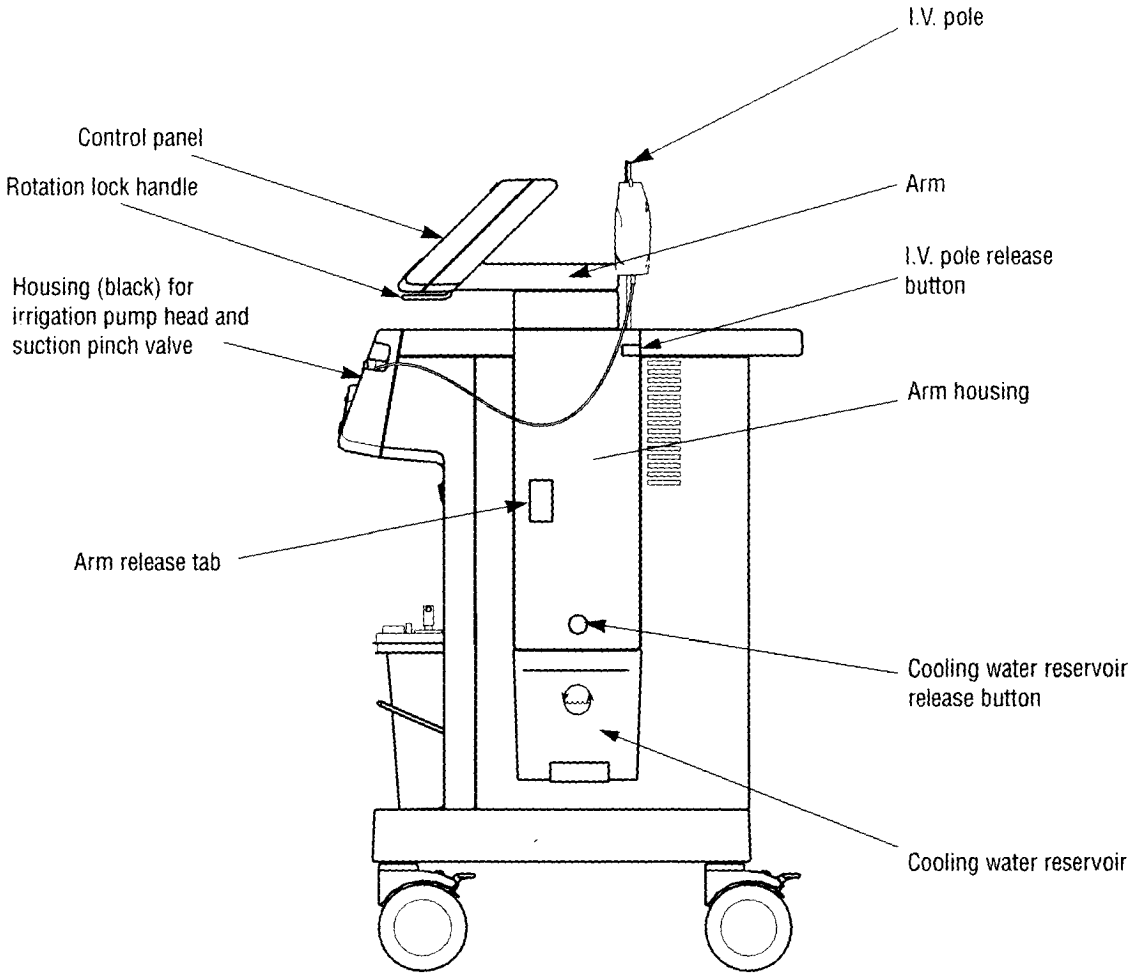
Protects the vacuum pump from particulate matter and moisture in the suction stream. It is necessary to replace the contamination guard every six months or when it becomes blocked.

Retaining Bail for Suction Canister

The bail holds the suction canister in place on the shelf.

Console Body Side Panel

Figure 4-5.
Console body—view of the right side



Control Panel

Refer to pages 4-4 through 4-7.

Rotation Lock Handle

This handle releases the control panel, allowing it to swivel and lock into one of four positions:

- Straight forward
- 45° right
- 45° left
- 90° left.

Housing for Irrigation Pump Head and Suction Pinch Valve

Refer to pages 4-2 and 4-3.

I.V. Pole

Refer to pages 4-2 and 4-3.

I.V. Pole Release Button

This button releases the I.V. pole, allowing you to raise it or lower it.

Arm and Arm Housing

Refer to pages 4-2 and 4-3.

Arm Release Tab

This tab releases a lock that holds the arm in three vertical positions.

Cooling Water Reservoir

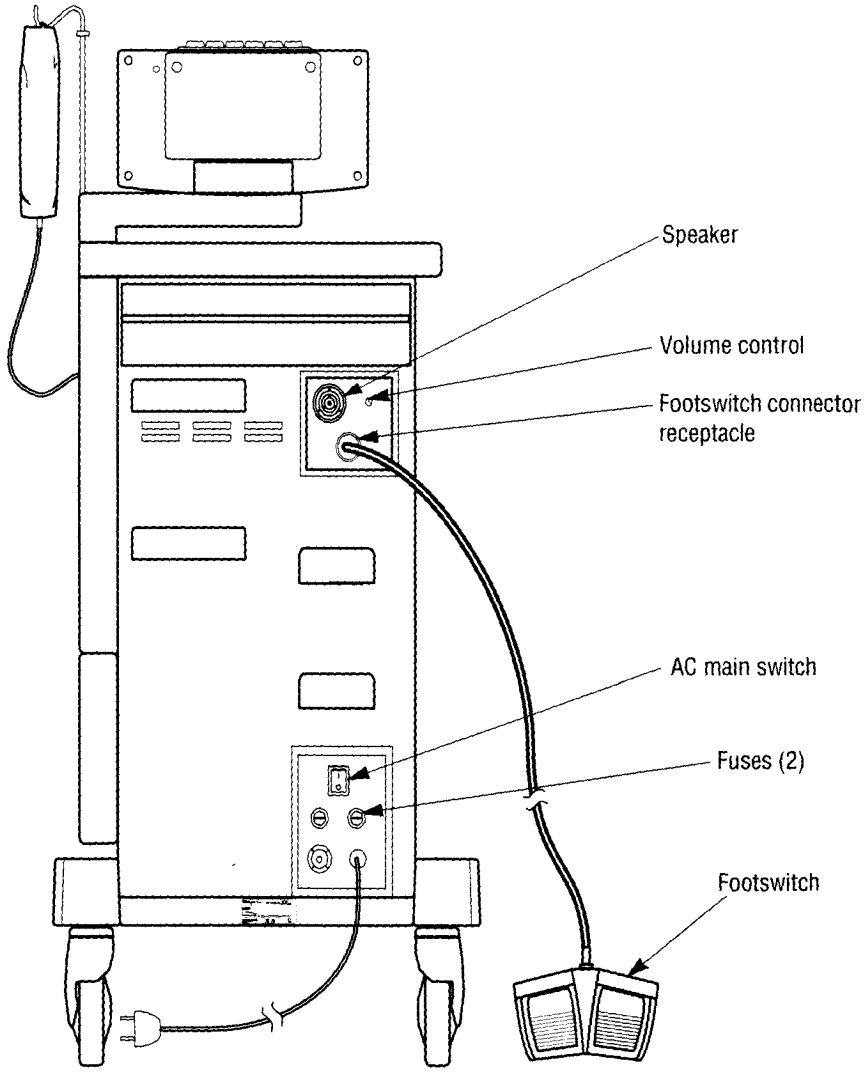
This container holds cooling water to be continuously circulated through the handpiece. The reservoir holds 1000 cc of distilled water.

A clear panel, which runs vertically up the side, allows you to see the water level inside the reservoir.

The reservoir also includes fittings that snap into receptacles inside the Arm Housing on the console side panel. The fittings and receptacles automatically connect the reservoir to the cooling water system.

Console Body Rear Panel

Figure 4-6.
Console—rear view



Speaker

The speaker sounds an audible tone when an alert condition exists and when vibration is active.

Volume Control

This potentiometer allows you to adjust the active vibration audible tone. You cannot adjust the alert tone.

Footswitch Connector Receptacle

This receptacle allows you to connect the footswitch to the console.

AC Main Switch

This switch controls the flow of AC power to the CUSA EXcel system. It does not activate the system; instead, it allows power to flow from the wall receptacle to the System Power Switch.

Once the AC Main Switch is On (|), you can leave it On even when you unplug the system from the wall receptacle.

Fuses

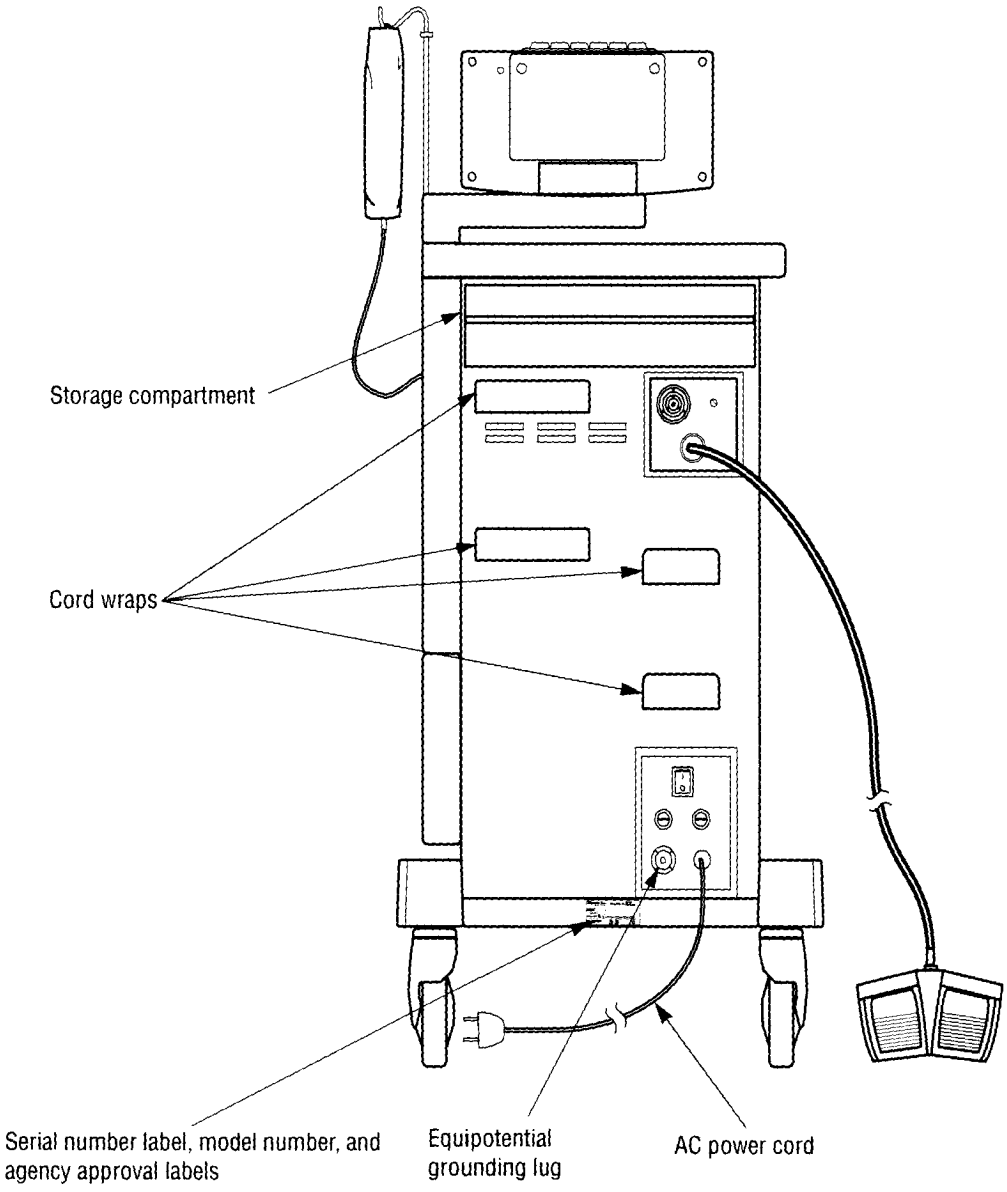
These protect the system from electrical overloads. Refer to Section 11, *Replacement Procedures* for instructions on replacing the fuses.

Footswitch

The footswitch has two pedals in a base, and allows you to activate two functions:

- Ultrasonics/vibration: Right pedal (orange), when pressed, activates vibration at the tip. When you release the pedal, vibration stops.
- Fast Flush: Left pedal (blue), when pressed, increases the irrigation rate to 25 to 30 cc/min. It also closes the Suction Pinch Valve, stopping suction. When you release the pedal, irrigation returns to the setpoint value and suction resumes.

Figure 4-7.
Console—rear view (continued)



AC Power Cord

Connects power to the system from the wall receptacle.

Equipotential Grounding Lug

If you are using a CEM generator, the grounding lug allows you to connect ground from the CEM generator to the CUSA EXcel console.

Label

The label shows the console serial number, model number, and agency approvals.

Cord Wraps

The unit has two cord wraps. These are brackets that allow you to hang two coils of cord on the back of the unit, keeping the cords safely out of the way.

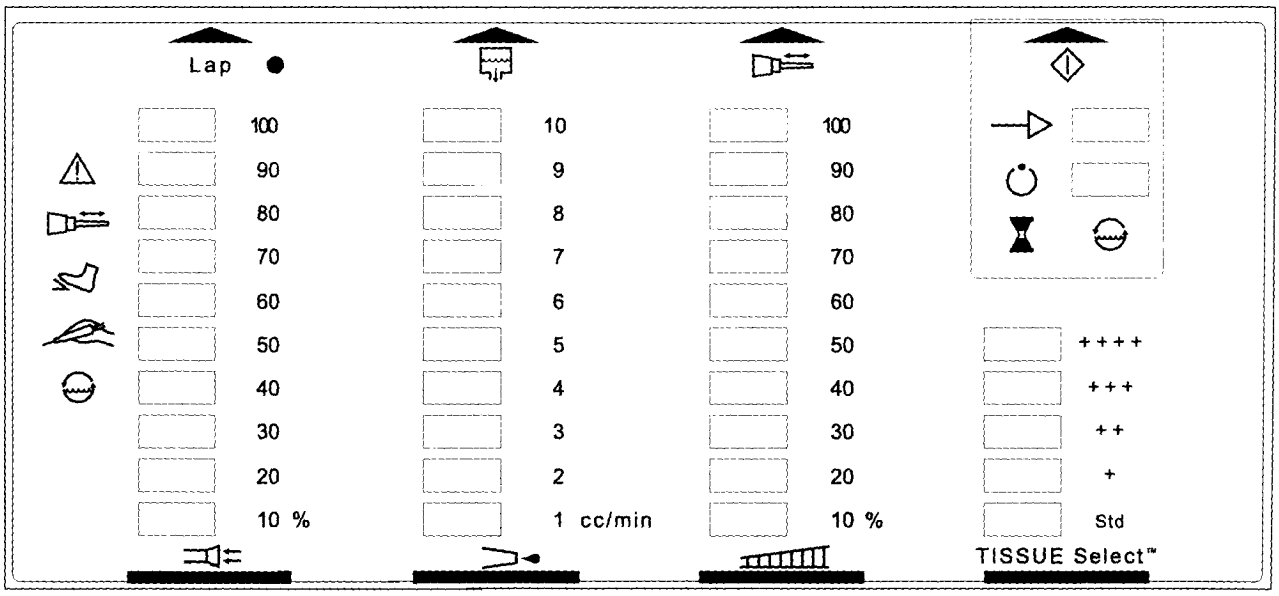
Storage Compartment

This area, which includes one interior shelf, allows you to store a footswitch and a manual.

Symbols on the Control Panel

Some symbols appear on the control panel. The following list shows each symbol and its meaning.

Figure 4-8.
Control panel symbols



Alert

Vibration:

Alert (red, left side of panel) – amplitude out of range

Test (amber, top of amplitude display) – system in Test mode

Footswitch failure or footswitch not connected

Handpiece failure or handpiece not connected

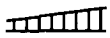
Cooling water:

Alert (red, left side of the control panel)—failure

Wait (amber, right side of the control panel)—system is circulating cooling water through the handpiece or draining the handpiece

Suction

Irrigation



Amplitude adjust

Std **Standard**

Pause/wait

Standby

Run

Start action/change status

Prime

On/selected

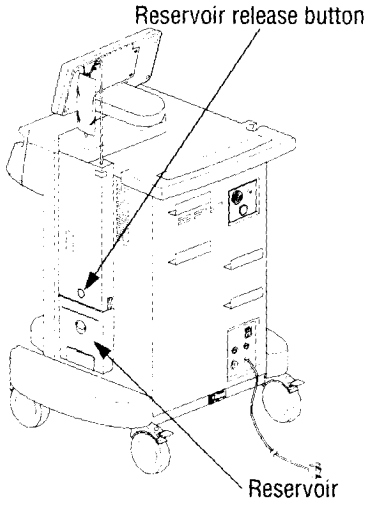
Lap **Laparoscopic mode**

Other Features

The CUSA EXcel console offers other convenient features:

- Easy-to-fill cooling water reservoir
- Adjustable arm height
- Rotating control panel
- Adjustable audible tone
- Adjustable I.V. pole.

The next portion of this section tells you how to use these features.



Filling the Cooling Water Reservoir

To remove the cooling water reservoir,

1. Press the cooling water reservoir release button (just above the reservoir) on the arm housing to release the fittings inside the housing.
2. Slide the reservoir toward the rear of the console.

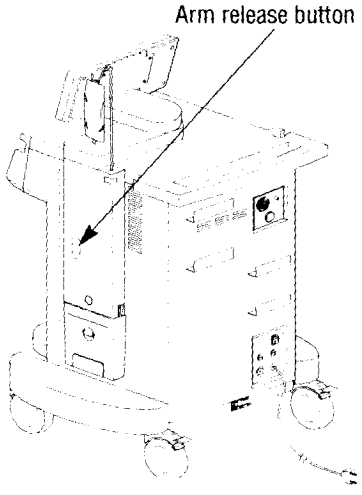
To fill the reservoir,

1. Gently open the rubber lid on the reservoir top.
2. Fill the reservoir with 1000 cc distilled water (to the line).
3. Close the rubber lid on the reservoir top.

To attach the cooling water reservoir, slide it into the slot on the console side panel until it snaps into place.

Raising/Lowering the Arm

It is possible to raise the arm that supports the control panel to allow a CEM unit to sit on top of the CUSA EXcel console or to see the control panel more easily over obstacles. A locking mechanism holds the arm at one of three positions: normal (lowest position), 7.6 cm above normal, and 15.2 cm above normal.



To adjust the arm position, follow these steps:

1. With one hand, press the release tab (rectangular) on the arm housing to disengage the lock. Once you have disengaged the lock and started to move the arm, it is not necessary to continue pressing the button.
2. With the other hand, grasp the arm and push gently up or down. A counterweight balances the arm, making it easy to raise or lower.
3. Continue to move the arm up or down until it reaches the next position at which the lock engages. You will feel and hear the arm click into place in the locked position.
4. If you want to move the arm to another position, press the release tab again and continue to push gently on the arm.

Rotating the Control Panel

The control panel rotates and locks into one of four positions:

- Straight forward
- 45° right
- 45° left
- 90° left.

To rotate the control panel from one position to another, do this:

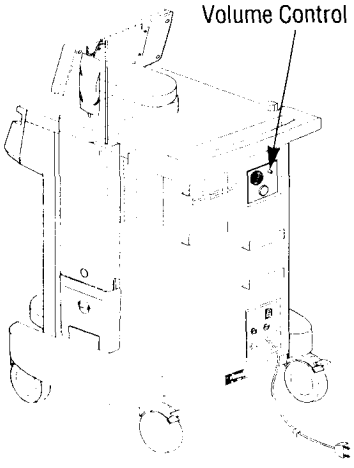
1. Grasp the release handle located under the control panel, and pull the handle forward.
2. While holding the handle in this position, rotate the control panel out of its previous position, then release the handle.
3. Continue to rotate the control panel. At its next locking position, it will automatically lock into place.

Adjusting the Tone Volume

The CUSA EXcel system includes an audible tone that sounds in two circumstances:

- When you press the Ultrasonics pedal on the footswitch to activate tip vibration
- When any alert activates.

Ultrasonics Tone



This tone (constant) sounds when you press the Ultrasonics pedal on the footswitch. You can adjust its volume.

To adjust tone volume, rotate the stem on the volume control potentiometer located just above and to the right of the footswitch connector receptacle on the console rear panel:

- Volume up—clockwise
- Volume down—counterclockwise

Note: At its lowest volume, the ultrasonics tone is barely audible. You cannot turn off the ultrasonics tone.

Alert Tone

This tone (on/off) sounds when an alert activates. You cannot adjust the volume of the alert tone.

Adjusting the I.V. Pole

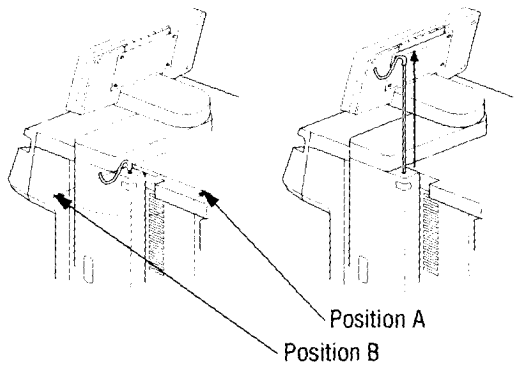
The I.V. pole, located at the top rear of the arm housing, adjusts to two locking positions: down or up. A spring-loaded locking pin slides into a recessed area on the pole to serve as a lock on the pole's up/down motion. A button, located just under the opening in which the pole rests in the arm housing, releases the locking pin.

When in the down position, the pole also rotates approximately 90° allowing two positions:

- Parallel to the console side (position A)
- At a right angle to the side (position B).

When in the up position, the pole does not rotate. It remains at position B. Notice that the I.V. bag does not hang over the console.

When a CUSA EXcel unit is shipped, the I.V. pole is in position A.



Raise the Pole

To raise the I.V. pole, do this:

▶ ***Important***

Do not try to raise the pole from Position A. Do not try to rotate the pole when it is in the upper position.

1. Grasp the pole and rotate it to position B.
2. With one hand, hold the pole; with the other hand, press the button to release the locking pin.
3. Raise the pole. As the pole clears its lower locking position, release the button.
4. Continue to move the pole upward until it locks into position.

Lower the Pole

To lower the I.V. pole, do this:

1. With one hand, hold the pole; with the other hand, press the button to release the locking pin.
2. Gently lower the pole. As the pole clears its upper locking position, release the button.
3. Continue to move the pole downward until it locks into position.
4. After the pole has locked into its lower position, you can rotate it to position A.

Technical Specifications

In this section:

- Console dimensions
- Console subsystems
- Electrical requirements
- Environment
- Standards and IEC classifications
- Handpieces
- Tip specifications.

Console Dimensions

CUSA EXcel Console

Height	1.32 m
Width	55.88 cm
Depth	71.12 cm
Weight	95.3 kg

Footswitch

Height	5.08 cm
Width	30.48 cm
Cable length	4.575 m

Console Subsystems

Ultrasonic

Nominal Frequencies	23 kHz 35.75 kHz
Maximum Tip Amplitudes (23 kHz)	Up to 355 microns for straight handpiece Up to 183 microns for angled handpiece
Maximum Tip Amplitude (36 kHz)	Up to 210 microns

Fluidic System

Cooling System	Cooling water flow is 35–50 cc/min
Irrigation Rate	The irrigation rate display shows digits 1–10 The irrigation rate is approximately 1–10 cc/min, normal; 25–30 cc/min, Fast Flush
Suction System	Up to 660 mm mercury at the pump intake at sea level The suction level will be lower at higher altitudes.

Electrical Requirements

Input Power Source

Power Rating

The CUSA EXcel system operates on one of the following voltage ranges	220–240 Volt (default) 95–120 Volt
Frequencies	50 Hz ± 2 Hz 60 Hz ± 2 Hz

Line fusing resides in fuse receptacles on the rear panel. The fuse values for 220–240 Volt operation are T5A; for 95–120 Volt operation, T10A. Refer to Section 11, *Replacement Procedures* for instructions on replacing the fuses.

Power Cords

Cord	Harmonized type three conductor cord
Connector	Continental European connector

If a facility intends to use the CUSA EXcel system in an operating room with another type of receptacle, the facility is responsible for replacing the connector on the power cord. The replacement connector must be properly grounded.

Warning

Explosion Hazard Do not use the CUSA EXcel system in the presence of flammable anesthetics or any potentially explosive or flammable atmosphere.

Low Frequency Leakage

Enclosure leakage current	<300 µA
Patient leakage current	<100 µA

Duty Cycle

Under maximum loading conditions, the CUSA EXcel console is suitable for ultrasonics activation times of 10 minutes on, 5 minutes off.

Environment

Operating temperature range	10° C to 40° C
Operating humidity range	15 to 80%, relative humidity, non-condensing
Operating atmospheric pressure range	70 kPa to 106 kPa
Storage and shipping temperature	-34° C to 65° C
Storage and shipping humidity	25 to 85% relative humidity, non-condensing

The system requires a minimum of one hour exposure at its operating temperature range before you use it.

Standards and IEC Classifications

ATTENTION
Consult accompanying documents.

DANGER
Explosion risk if used with flammable anesthetics.

EQUIPOTENTIAL GROUND
Connect equipotential ground cable here.

POWER ON
Applies power at the AC Main Switch and the System Power Switch.

POWER OFF
Removes power at the AC Main Switch.

PROTECTIVE EARTH GROUND

CAUTION
To reduce the risk of electric shock, do not remove the cover. Refer servicing to qualified service personnel.

Classified with respect to electrical shock, fire, mechanical, and other specified hazards only in accordance with UL60601-1 and CAN/CSA C22.2 No. 601.1.

Class I Equipment (IEC 601-1)

Accessible conductive parts cannot become live in the event of a basic insulation failure because of the way in which they are connected to the protective earth conductor.

Type BF Applied Part Equipment (IEC 601-1)

The CUSA EXcel console provides a high degree of protection against electric shock, particularly regarding allowable leakage currents. It is type BF isolated (floating) output.

IPX - 8 (IEC 529, UL 60601) Footswitch

The CUSA EXcel footswitch includes protection against the effects of continuous immersion in water.

Electromagnetic Interference

The CUSA EXcel console minimizes electromagnetic interference to other equipment used in the operating room. The system complies with the requirements of IEC 801.

Note that other devices in the operating room may generate electromagnetic interference. Use caution in locating equipment within the room to reduce the electromagnetic interference.

System Power Off / Standby

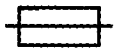
When you turn off the System Power Switch, the system automatically drains water from the cooling water system and deactivates other system components. It also maintains power to the logic circuitry to monitor the System Power Switch position.

Pinch Point in the Suction Pinch Valve

The suction pinch valve may pose a hazard during normal use.

Caution

To avoid injury to surgical personnel, keep fingers away from the suction pinch valve while powering the unit on or off, activating vibration, or using fast flush.



Fuse Replacement

Indicates the location of the fuse holder on the rear panel.

Footswitch Symbols

The following symbols appear on the CUSA EXcel footswitch:

Activate vibration.

Activate fast flush (irrigation).

Voluntary Standards

The CUSA EXcel system meets the following standards:

- **UL 60601-1**
- **cUL/CSA** Test requirements: (CSA 22.2, No. 601.1)
- **IEC 601-1** Medical electrical equipment: General requirements for safety
- **IEC 60601-1-2** Second edition
- **CISPR11** Class A electromagnetic compatibility for industrial-process measurement and control equipment: Emissions requirements
- **ISTA** Pre-Shipment Test Procedures, Project 2A.

Statutory and Regulatory Requirements

Class II Medical Device (Special Controls)

EMC Compatibility

Notice

The CUSA EXcel should not be used adjacent to or stacked with equipment other than specified in the CUSA EXcel User Guide and Service Manual. If adjacent or stacked use is necessary, the CUSA EXcelEXcelEXcel should be observed to verify normal operation in the configuration in which it will be used.

The electrical surgical generator used with the CUSA EXcel intentionally applies RF energy for diagnosis or treatment during activation. Observe other electronic medical equipment in the vicinity during the CUSA EXcel activation for any possible adverse electromagnetic effects. Ensure adequate separation of electronic medical equipment based on observed reactions.

The use of accessories, other than specified in the CUSA EXcel User Guide and Service Manual, may result in increased emissions or decreased immunity of the CUSA EXcel.

Guidance and manufacturer's declaration - electromagnetic emissions		
The CUSA EXcel is intended for use in the electromagnetic environment specified below. The customer or the user of the CUSA EXcel should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment - guidance**
RF emissions CISPR 11	Group 1	The CUSA EXcel uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A	The CUSA EXcel is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC61000-3-3	Complies	
Guidance and manufacturer's declaration - electromagnetic emissions		
The CUSA EXcel is intended for use in the electromagnetic environment specified below. The customer or the user of the CUSA EXcel should assure that it is used in such an environment.		

Guidance and manufacturer's declaration - electromagnetic immunity			
The CUSA EXcel is intended for use in the electromagnetic environment specified below. The customer or the user of the CUSA EXcel should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment - guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	+/-6 kV contact +/-8 kV air	+/-6 kV contact +/-8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	+/-2 kV for power supply lines +/-1 kV for input/output lines	+/-2 kV for power supply lines +/-1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	+/-1 kV differential mode +/-2 kV common mode	+/-1 kV differential mode +/-2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5% Ut (>95% dip in Ut) for 0,5 cycle 40% Ut (>60% dip in Ut) for 5 cycles 70% Ut (>30% dip in Ut) for 25 cycles <5% Ut (>95% dip in Ut) for 5 sec	<5% Ut (>95% dip in Ut) for 0,5 cycle 40% Ut (>60% dip in Ut) for 5 cycles 70% Ut (>30% dip in Ut) for 25 cycles <5% Ut (>95% dip in Ut) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment. If the user of the CUSA EXcel requires continued operation during power mains interruptions, it is recommended that the CUSA EXcel be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE Ut is the a.c. mains voltage prior to the application of the test level.			

The CUSA EXcel is intended for use in the electromagnetic environment specified below. The customer or the user of the CUSA EXcel should assure that it is used in such an environment.

Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment - guidance**
			Portable and mobile RF communications equipment should be used no closer to any part of the CUSA EXcel, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance
Conducted RF IEC 61000-4-6	3 Vrms 150KHz to 80MHz	3 V	$d=1/2\sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80MHz to 2.5GHz	7 V/m	$d=0.5\sqrt{P}$ 80MHz to 800MHz $d=\sqrt{P}$ 800MHz to 2.5GHz Where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, should be less than the compliance level in each frequency range Interference may occur in the vicinity of equipment marked with the following symbol:

NOTE 1 At a80MHz and 800MHz, the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

a. Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the CUSA EXcel is used exceeds the applicable RF compliance level above, the CUSA EXcel should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the CUSA EXcel.

b. Over the frequency range 150kHz to 80MHz, field strengths should be less than 3 V/m.

The CUSA EXcel is intended for use in the electromagnetic environment specified below. The customer or the user of the CUSA EXcel should assure that it is used in such an environment.

Recommended separation distances between portable and mobile RF communication equipment and the CUSA EXcel

The CUSA EXcel is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The Customer or the user of the CUSA EXcel can help prevent electromagnetic interferences by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the CUSA EXcel as recommended below, according to the maximum output power of the communications equipment.

Rated maximum output power of transmitter (W)	**Separation distance according to frequency of transmitter (m)**		
	150 kHz to 80MHz $d=1.2\sqrt{P}$	80MHz to 800MHz $d=0.5\sqrt{P}$	800MHz to 2.5GHz $d=\sqrt{P}$
0.01	.12 m	0.05 m	0.1 m
0.1	.38 m	0.16 m	0.32 m
1	1.2 m	0.5 m	1 m
10	3.8 m	1.6 m	3.2 m
100	12 m	5 m	10 m

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1 At a80MHz and 800MHz, the separation distance for the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Handpieces

Nominal Frequencies

23 kHz Straight	23 kHz
23 kHz Angled	23 kHz
36 kHz Straight	35.75 kHz

Dimensions

23 kHz Straight

Length	22.2 cm
Diameter	20.8 mm

23 kHz Angled

Length	22.2 cm
Diameter	20.8 mm

36 kHz Straight

Length	13.9 cm
Diameter	16.4 mm

Tip Specifications

The table on page 5-9 shows specifications for tips that attach to the 23 kHz handpiece.

The table on page 5-10 shows specifications for tips that attach to the 36 kHz handpiece.

23 kHz

Table 5-1.
Tip Specifications—23 kHz

Tip	Length (cm)	ID (mm)	OD (mm)	Amplitude (peak to peak) µm	Weight (g)
Standard Tip	7.98	1.98	2.54	Straight Handpiece: 287 to 355 Angled Handpiece: 112 to 163	3.54
MicroTip	9.22	1.57	1.93	Straight Handpiece: 279 to 355 Angled Handpiece: 127 to 183	3.99
Straight Extended Standard Tip	18.38	1.98	2.54	Straight Handpiece: 287 to 355 Angled Handpiece: 112 to 163	16.15
Curved Extended Standard Tip	18.38	1.98	2.54	Straight Handpiece: 287 to 355 Not compatible with angled handpiece	16.15
MacroTip	7.95	2.64	3.18	Straight Handpiece: 254 to 307 Angled Handpiece: 102 to 142	3.84
Laparoscopic Tip	30.14	1.98	2.54	Straight Handpiece: 178 to 229 Not compatible with angled handpiece	32.13
Extended Life Standard Tip	7.98	1.98	2.54	Straight Handpiece: 287 to 355 Angled Handpiece: 112 to 163	3.54
Extended Life Macro Tip	7.95	2.64	3.18	Straight Handpiece: 254 to 307 Angled Handpiece: 102 to 142	3.84

36 kHz

Table 5-2.
Tip Specifications—36 kHz

Tip	Length (cm)	ID (mm)	OD (mm)	Amplitude (peak to peak) µm	Weight (g)
PrecisionTip	5.64	1.14	1.45	191 to 210	1.37
Straight Extended PrecisionTip	12.51	1.14	1.45	191 to 210	7.86
Curved Extended PrecisionTip	12.51	1.14	1.45	191 to 210	7.86
MicroTip	5.28	1.57	1.93	175 to 193	1.30
Straight Extended MicroTip	12.15	1.57	1.93	175 to 193	7.50
Curved Extended MicroTip	12.15	1.57	1.93	175 to 193	7.50
Standard Tip	4.57	1.98	2.54	137 to 155	1.31
Straight Extended Standard Tip	11.44	1.98	2.54	137 to 155	7.48
Curved Extended Standard Tip	11.44	1.98	2.54	137 to 155	7.48
Extended Life Curved Extended PrecisionTip	12.51	1.14	1.45	175 to 210	7.86
Extended Life Curved Extended MicroTip	12.15	1.57	1.93	165 to 193	7.50
Extended Life Curved Extended Standard Tip	11.44	1.98	2.54	137 to 155	7.48

Principles of Operation

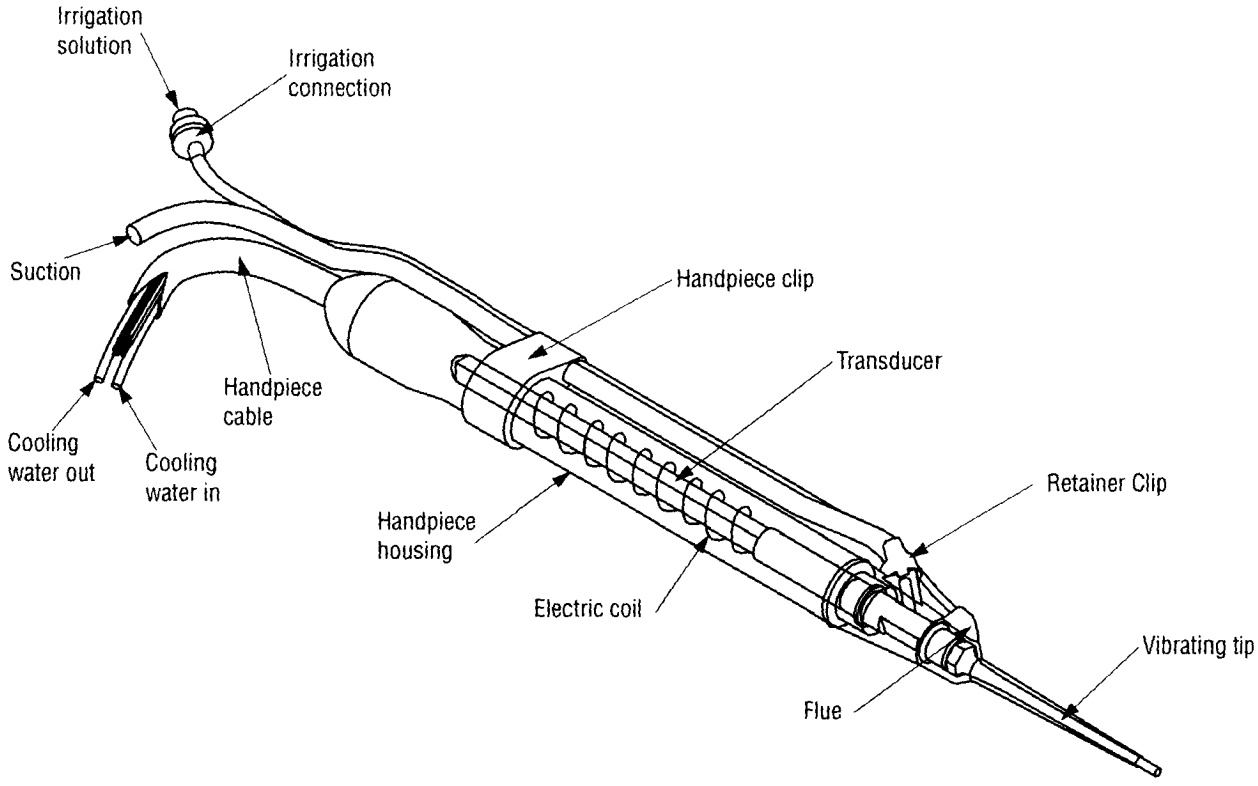
In this section:

- How the handpiece works
  - Electromechanical operation
  - Fragmentation
  - Cooling
- How the TISSUE Select feature works
  - Inherent tissue selectivity
  - Increasing tissue selectivity
  - TISSUE Select reduces reserve power to the tip
  - Benefits of TISSUE Select
  - A common misunderstanding of the amplitude setting.

How the Handpiece Works

The handpiece converts electrical energy to mechanical energy, resulting in vibration in the handpiece, and from the handpiece through a connecting body to a hollow titanium tip. When it contacts tissue, the tip fragments the tissue. The conversion of electrical energy to mechanical energy generates heat; a cooling system reduces the heat in the handpiece.

Figure 6-1.
The handpiece components



Electromechanical Operation

The CUSA EXcel console provides alternating current at 23 or 35.75 thousand cycles per second (kHz) to the handpiece (the frequency depends on which handpiece you connect to the console). In the handpiece, the current passes through a coil, which induces a magnetic field. The magnetic field excites a transducer of nickel alloy laminations, resulting in an oscillating motion in the transducer laminated structure—vibration—along its long axis. The transducer vibrates at 23 or 35.75 kHz.

The transducer transmits vibrations through a metal connecting body to an attached surgical tip. The frequency of vibration remains the same at the tip (23 or 35.75 kHz), but the amount of motion (amplitude) at the tip varies: Lower frequency, greater amplitude; higher frequency, smaller amplitude.

Amplitude also varies with the transducer/connecting body/tip configuration: Handpiece angle reduces tip amplitude.

A small feedback coil in the handpiece generates a signal (voltage) that is proportional to the amount of motion in the transducer. The console uses the feedback signal to adjust the power sent to the handpiece. For example, if the transducer motion decreases due to resistance from tissue, the feedback signal decreases. As the feedback signal decreases, the console increases power to the handpiece to return transducer motion to normal value.

Fragmentation

Fragmentation occurs when the vibrating tip interacts with tissue. As the tip begins to move toward tissue, it accelerates, impacts the tissue, then penetrates the tissue. The acceleration, impact, and penetration produce a combination of direct mechanical forces and hydrodynamic pressures that burst cells.

Cooling

The high frequency vibration generates heat. To reduce the heat, the CUSA EXcel system includes a closed, recirculating cooling water system. This system pulls water from a cooling water reservoir, through a tube in the handpiece cable, through the handpiece, and through a return tube in the handpiece cable to the cooling water reservoir. Cooling water flows at 35 to 50 cc/min.

As it passes through the handpiece, the water removes heat.Normal handpiece temperature, in sustained heavy use, remains at about 40° C.

Use distilled water for the cooling water system because it does not contain natural minerals, chemical additives, or organic materials that are present in tap water. Any of these impurities in tap water can cause problems within the cooling water system.

How the TISSUE Select Feature Works

TISSUE Select is a feature that allows the surgeon to maintain a high fragmentation rate while increasing selectivity and control at the surgical site.

Fragmentation occurs when the vibrating tip interacts with tissue. As the tip begins to move toward tissue, it accelerates, then impacts and penetrates the tissue. The acceleration, impact, and penetration produce a combination of direct mechanical forces and hydrodynamic pressures that burst cells.

Several variables affect the fragmentation rate. Most are functions of the CUSA EXcel system:

- Stroke (tip excursion—the total distance the tip travels)—greater stroke results in greater fragmentation rate.
- Suction
  - Suction has two functions:
    - **(1)** It draws tissue toward the vibrating tip and creates a tip/tissue coupling effect.
    - **(2)** It removes irrigation and fragmentation debris from the surgical site.
  - If there is no suction or low suction, coupling does not occur, resulting in minimal tissue fragmentation and increased tissue temperature.
- Tip acceleration—produces the peak forces and pressures that fragment tissue.
- Tip cross-sectional area at the tip-tissue contact site.

These variables also affect tactile feedback—what the surgeon's hand feels when using the handpiece.

Inherent Tissue Selectivity

With all other variables remaining constant, the tip does not fragment all tissue types equally effectively. Another variable—tissue strength—affects fragmentation rate.

- "Low strength" tissues (easiest to fragment) include the brain and most organs. Older, partially dried tissues are also easy to fragment. "High strength" tissues (most difficult to fragment) include vessel structures, tendons, ligaments, healthy skin, and organ capsules.
- Strength increases and fragmentation rate decreases with tissue containing greater collagen, elastin, or both (collagen type, quantity, and organization affect cell structural quality).

Tissue strength also affects tactile feedback. The surgeon can feel a difference between the tip contacting low-strength tissue and the tip contacting high strength tissue. As the tip works through low strength tissue, the surgeon feels a smooth, rhythmic sensation from the handpiece. When the tip contacts high strength tissue, it feels like it is "bouncing off" the tissue. Also, the smooth, rhythmic sensation becomes rougher. To avoid fragmenting high strength tissue, the surgeon must apply less pressure to the tip or move the tip away from the tissue. To continue fragmenting high strength tissue, the surgeon must manually apply more pressure.

However, the surgeon may not always recognize the difference in tactile feedback quickly enough, or react quickly enough, to avoid damaging vital structures, particularly those with a tissue strength similar to the tissue being fragmented. Fortunately, the CUSA EXcel system can help the surgeon avoid these problems when dissecting near vital structures.

Increasing Tissue Selectivity

It is possible to increase the inherent selectivity resulting from variations in tissue strength while maintaining stroke amplitude, tip acceleration, and suction. This increase in selectivity results from reducing the reserve power that drives the tip.

The CUSA EXcel ultrasonic generator delivers electrical power (which is directly related to the acoustic power present at the tip, which results in fragmentation) to the handpiece. You can think of the power delivered to the handpiece in three terms:

- Initial power—the quantity of power necessary to drive the tip vibration in air; that is, no contact with tissue.
- Reserve power—the power necessary to maintain tip vibration under load (in contact with tissue). When the tip encounters load, a feedback loop in the system senses the additional load and provides additional reserve power to maintain tip vibration.
- Maximum power—the greatest power output the console can provide. Maximum power is the sum of initial and reserve power.

TISSUE Select Reduces Reserve Power to the Tip

The TISSUE Select feature increases both the inherent selectivity and the tactile feedback of the vibrating tip by reducing the reserve power the ultrasonic generator provides to the handpiece.

How does it reduce the power? One of the variables of power consumption is time: reduce time, reduce power consumed. To reduce power consumption, the ultrasonic generator reduces the time that it provides electrical power. Specifically, rather than providing power continuously, it provides power at measured on-off intervals:

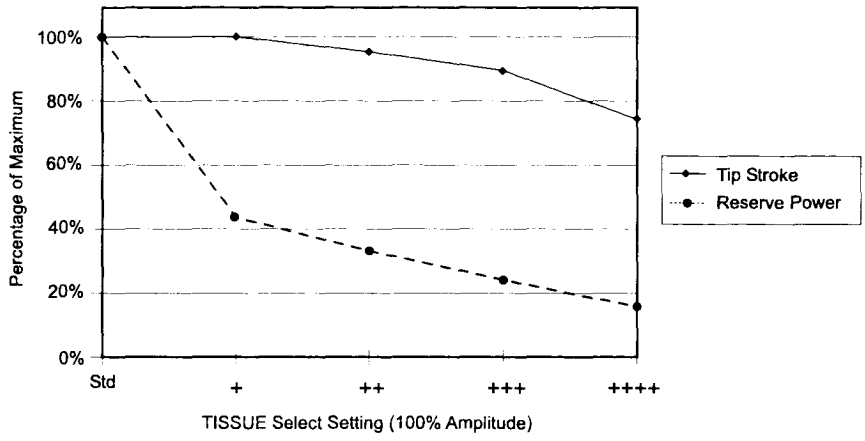
Table 6-1.
On-off intervals for TISSUE Select

Setting	On-Time	Off-Time
Std	continuous	0 ms*
+	40 ms	10 ms
++	30 ms	10 ms
+++	20 ms	10 ms
++++	10 ms	10 ms

**1 ms = 1 millisecond = 1 one-thousandth of a second*

Power decreases as on-time decreases.

Figure 6-2.
Reserve power vs. TISSUE Select settings



At a 100% Amplitude setting, as TISSUE Select settings increase, on-time and reserve power decrease.

The TISSUE Select feature offers five settings from "std" (standard—least selective) to ++++ (most selective). The std setting selects continuous power, resulting in ample reserve power. The ++++ setting selects the least power.

Standard Operation

Power is continuous. The ultrasonic generator provides ample reserve power; more than is necessary to drive stroke amplitude under heavy load:

- The tip fragments "softer" tissue easily.
- The tip fragments "stronger" tissue, but with more difficulty (slower, requires more surgeon pressure).

TISSUE Select Operation

Power is interrupted. The ultrasonic generator provides less reserve power to the handpiece:

- The tip still fragments "softer" tissue easily.
- But, when it encounters "stronger" tissue, the power the tip receives is no longer enough to fragment the tissue. The tip stalls.

At increased selectivity settings (+ to ++++), suction and the tip cross-sectional area remain the same, and stroke amplitude and tip acceleration decrease slightly:

Table 6-2.
Fragmentation performance vs. TISSUE Select settings

Setting	Fragmentation Rate
Std and +	maximum
++ and +++	slightly decreased rate, increased tissue selectivity and tactile feedback
++++	slowest rate, maximum selectivity and tactile feedback

Benefits of TISSUE Select

The TISSUE Select feature presents several benefits:

- Maintains fragmentation ability.
- Reduces (automatically) fragmentation rate.
- Provides maximum tissue selectivity.
- Gives surgeon superior tactile feedback.
- Gives surgeon greater control and precision when dissecting near delicate structures.

A Common Misunderstanding of the Amplitude Setting

It has been common practice to decrease the amplitude setting when encountering critical structures. The reasoning behind this practice is that the lower amplitude setting results in slower fragmentation rate and greater selectivity, thus greater control to help avoid damage when dissecting near the critical structures. Look at this reasoning more carefully.

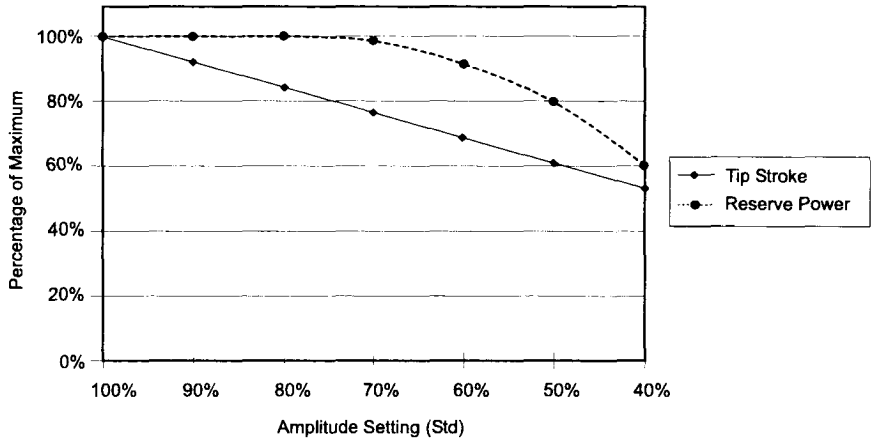
True: Decreasing the amplitude setting also decreases the fragmentation rate.

True: Because the fragmentation rate is slower, the surgeon has a little more time to move the tip away from a critical structure before damaging it; therefore, the surgeon *seems* to have greater selectivity and control.

False: The surgeon gains greater selectivity, thus greater control and precision when dissecting near critical structures.

Why does the decrease in amplitude not give greater selectivity and control? Decreasing the amplitude does not greatly affect the reserve power.

Figure 6-3.
Reserve power vs. amplitude setting



Decreasing the amplitude leaves plenty of reserve power.

When the tip contacts critical structures, it still has more than enough power to fragment them if the surgeon applies pressure or prolongs the tip-tissue contact. Therefore, decreasing the amplitude setting gives the following results:

- Reduced fragmentation ability
- Reduced fragmentation rate
- Little increase in selectivity
- Little reduction in reserve power.

Circuit Theory

In this section:

- Display board
- Machine control board
- Ultrasonics board–ultrasonic generator
- Ultrasonics board–other circuits
- Dual 24 V Power Supply board.

For Your Information

When reading the descriptions in this section, refer to the Schematics Supplement to view schematics.

Display Board

General Description

The display board contains the user information displays and user input buttons for the unit. User input buttons control the following settings and functions:

- Settings:
  - Amplitude
  - Aspiration
  - Irrigation
  - TISSUE Select.
- Functions:
  - Status (run or standby)
  - Lap
  - Test
  - Prime.

The display board also includes four fault indicators (alerts):

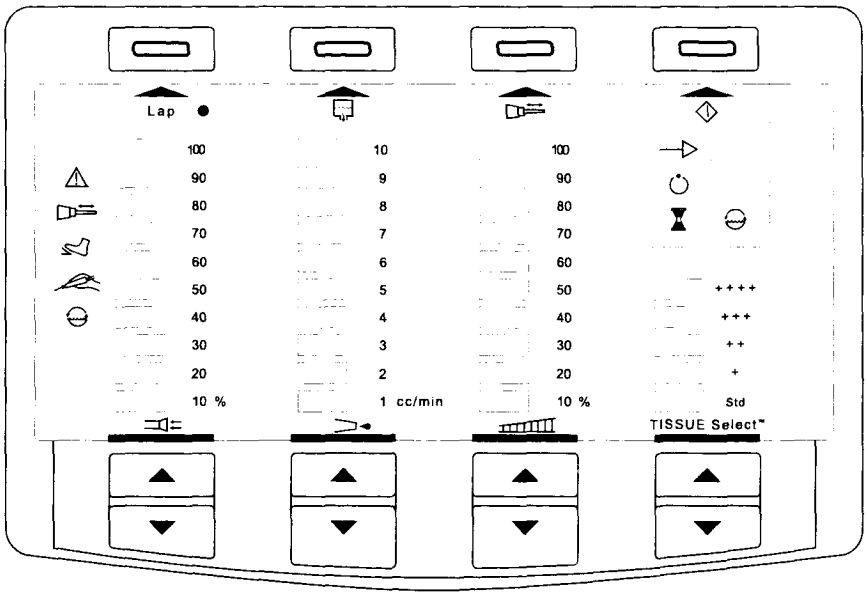
- Vibration
- Footswitch
- Handpiece
- Cooling water.

The PCB is a single, four-layer circuit board. It includes both through-hole and surface-mount parts due to space constraints on the board and the quantity of parts. The buttons and electronics provide bi-directional data communication with the machine control board via a 50-pin ribbon cable.

Fundamentals of Operation

The display board, the fundamental user interface for the system, both receives and displays information to the user. Figure 7-1 shows the display organization.

Figure 7-1.
The display organization on the control panel



Due to the quantity of LEDs, space restriction, and heating considerations, FET switches connected to a multiplexing display driver (Maxim 7218) drive the displays. A resistor in series with the LED light bar limits current through the LEDs. A P-channel FET sources the voltage to the resistor and LED light bar series combination. An N-channel FET sinks the current to ground from the LED light bars. The outputs of the 7218 display driver control the gates of the FETs.

To reduce the number of display drivers and the quantity of logic code, a coded map identifies each individual LED light bar location so that a single display driver can control all of the amplitude, irrigation, Tissue Select, and aspiration displays. A second display driver controls the number legends, the alerts, the status indicators, and the button indicators.

Detailed Circuit Description

Each "circuit" works the same way. It simply repeats several times to allow individual control over each light bar package. The following description details the circuit for the aspiration column at a setting of 10%.

The 7218 display driver (U3) receives inputs from the machine control board via the 50 pin ribbon cable connector, J1. The segment output of the display driver connects to a 1k pull-up resistor (RA2) and the gate of an N-channel FET (U66). The source of the FET ties to +5Vin and the drain connects to a resistor network (RA32). Several of the resistors are tied together to achieve an average current of 12 mA through each LED of the light bar for a total of 96 mA per light bar. The resistors, in parallel, connect in series with the light bar (U221). All diodes in the light bar connect in parallel. The cathode of the diode connects to the drain of the N-channel FET (U65). The source of U65 connects to ground. The gate connects to a digit output of U3 and a pull-down resistor (RA6).

For any light bar to be illuminated, it must receive both the correct segment and digit output from the display driver. Each LED light bar (except for the numeric legends) has a unique map location; thus, each LED light bar is independently controlled. The numeric legends are controlled together, not independently.

Machine Control Board

Introduction

The Machine Control board resides in the control panel assembly along with the Display board. The Machine Control interfaces with the ultrasonic section of the display and keypad. It also interfaces to the solenoid valves, pumps, and the ultrasonic drive circuitry. This description presents the Machine Control schematic. Refer to the Schematics Supplement.

Irrigation Pump

A resistor divider and operational amplifier network establishes control for the irrigation pump. The programmable logic device (PLD) sets the levels. The signals are optically isolated and sent as inputs to a quad analog switch. The analog switch selects gain resistors for an op amp, which is amplifying a dc level. The op amps output drives a pump speed controller (off board) which has a greater than 10k ohm input resistance.

The 5-bit output signal range for the irrigation pump is approximately 0 to 5V DC. The following table shows the irrigation steps:

Table 7-1.
Irrigation pump voltage steps

irrigation step		**5v_x = 5.6v**	
display	desired voltage	setpoint	theoret v
1	0.28	2	0.32
2	0.45	3	0.47
3	0.61	4	0.63
4	0.78	5	0.79
5	0.93	6	0.95
6	1.1	7	1.11
7	1.3	8	1.27
8	1.45	9	1.43

irrigation step		5v_x = 5.6v	
9	1.6	10	1.59
10	1.75	11	1.75
ff max	5	16	4.98

Suction Pump

Suction pump control results from the same kind of operation as irrigation pump control. The 4 bit output signal range for the suction pump is approximately 0 to 6V DC. The following table shows the suction steps:

Table 7-2.
Suction pump voltage steps

suction step		+5v_sp = 6.15v	
	desired voltage	setpoint	theoret v
		1	0.40
		2	0.80
		3	1.20
		4	1.61
		5	2.00
		6	2.41
		7	2.81
		8	3.23
		9	3.63
		10	4.03
default	4.4	11	4.43
		12	4.84
		13	5.23
		14	5.64
max	6	15	6.03

Cooling Pump

Cooling pump control results from the same kind of operation as irrigation and suction pump control. The 3-bit D/A output signal range for the cooling pump is approximately 0 to 5.1V DC. The following table shows the cooling steps:

Table 7-3.
Cooling pump voltage steps

cool step		+5v_x= 5.6v	
	desired voltage	setpoint	theoret v
		1	0.73
		2	1.46
default	2.208	3	2.19
		4	2.94
		5	3.67
		6	4.40
max	5.152	7	5.13

Suction Valve

Optically isolated digital circuits control the suction valve. When current moves through an internal LED, the output open collector transistor is saturated. The pull-up resistors and the controlling hardware reside on the destination board.

Amplitude Control

The handpiece amplitude control circuit, a 4-bit D/A output signal range for the handpiece control, operates from approximately 0 to 10V DC. The op amp maximum supply voltage is 15V, so two diode drops prevent the op amp from seeing the full 15V from the supply. The following table shows the handpiece amplitude control steps:

Table 7-4.
Handpiece amplitude control voltages

amp step	desired voltage	D/A code	theoret v
		1	1.00
		2	2.01
	2.208	3	3.01
		4	4.04

amp step	desired voltage	D/A code	theoret v
		5	5.04
		6	6.05
		7	7.05
		8	8.11
		9	9.11
max		10	10.13
		11	11.13
		12	12.15
		13	13.15
		14	14.16
		15	15.16

Valve Controls

Optical isolators condition signals to and from the ultrasonics board. The signals from the footswitch activate fast flush and the ultrasonics, and indicate whether the footswitch is present. There are several isolated solenoid valve drivers for controlling tissue release, suction, handpiece drain, and anti-siphon. The handpiece feedback signals from the ultrasonics board go through opto-isolators to the PLD. Alert signals such as cooling out of range, vibration, amplitude, and handpiece not present also pass through opto-isolators before going into the PLD.

Power Control Input and Output Signals

When you turn the system power switch on, the softpower circuit, an input to the PLD, activates all other systems. The shutdown handpiece bias signal, an output from the PLD, activates the handpiece bias. The keypad signals (originating at the display board) pass through filters, then go into the PLD. A power supervisor resets the PLD when the supply voltage is below specification. The power supervisor input is filtered with a time constant of 1mS to reduce the possibility of false resets. The crystal and inverter generate the PLD master clock at 32.768 kHz. The right angled 10-pin connector allows in-circuit programming of the PLD. An EE programmable read-only memory (prom) stores initial set points.

Voltage Regulators

There are voltage regulators for the isolated supplies. LM317 adjustable regulators provide op amps with supply voltages with enough overhead margin to output voltages in the required range. A switching regulator boosts and regulates the 5V supply for the machine control and display driver boards. This is necessary because the 5Vin signal is expected to dip momentarily due to the voltage drop when the displays are lit up. A diode placed around the regulator eliminates start up delay in the 5V supply for the PLD. This sheet shows bypass capacitors as well as the independent power shutdown driver circuits. The open collector output signals drive an opto-isolator LED inside the power modules in order to shut off the supplies.

Interface Connectors

J2 and J3 are the ultrasonics interface connectors. J1 is the 5V input power supply connector. J5 is the power shutdown control connector. J4 is the display board interface connector.

Ultrasonics Board–Ultrasonic Generator

Fundamentals of Operation

The CUSA EXcel ultrasonic generator is based on the principle of the Wien Bridge Oscillator. The system has a non-inverting feedback loop to establish the fundamental frequency of oscillation and an additional negative feedback loop, which controls the amplitude of oscillation. The fundamental oscillation component is a function of the resonant frequency of the magnetostrictive handpiece.

Oscillation criteria for a Wien Bridge are that the gain around the loop must add up to unity and the phase must add up to 360° or 0°. Only if the gain is initially greater than unity and some perturbation (noise) in the initial conditions of the system exists can startup occur.

The handpiece design uses the magnetostrictive and inverse magnetostrictive effects. A magnetic field produces a small change in the physical dimensions of ferromagnetic materials—on the order of several parts per million in steel—and, conversely, a physical deformation or strain (or stress which causes strain) produces a change of the magnetization in the material.

Much like a tuning fork excited by a "ping" or deformation, the handpiece transducer—excited by these small deformations caused by the magnetostrictive effect—resonates at an ultrasonic frequency. Linear operation within this framework relies on biasing the magnetic field at a roughly linear point along the main B-H curve. The feedback signal, sensing the change in the magnetic field produced by the inverse magnetostrictive effect, is proportional to the deformation.

A tip, designed as an ultrasonic velocity transformer or horn connected to the transducer or motor, makes use of the energy contained in the vibration of the handpiece. The horn also increases the stroke and velocity with minimal losses. The amount of transformation is referred to as "tip gain."

Temperature and load affect the frequency of vibration. If the transducer heats, its frequency decreases; if the transducer cools, its frequency increases. Transducer inefficiencies can cause "self-heating." Loading of the transducer can move the frequency up or down depending on hardness, viscosity, and elasticity. Either case requires a change in the amount of gain and phase from the generating circuit. Additionally, this circuit must be able to react as quickly as possible to the load changes; otherwise, the delivered power from the generator could exceed the elastic limit of the tip material and cause fractures.

The Main Frequency Loop

The frequency loop consists of the following items:

- A CUSA EXcel handpiece
- A bandpass filter (BPF)
- An AGC/error amplifier circuit
- A phase compensator
- A driver stage
- Feedback signal
- Bias circuitry
- Frequency selection circuitry.

The handpiece has many potential operating points. The console must choose one of these by way of some additional BPF function to select the phase and gain that meet the oscillation criteria over the desired frequency range of operation. Flat phase and gain over this region of interest is desirable; otherwise, poor power factors and/or unstable operation could result. The AGC loop controls the multiplier and, therefore, adjusts the frequency loop gain to control the amplitude under varying load and handpiece operating conditions. Linear operation of these two loops in conjunction is imperative to avoid handpiece operation at an undesired point.

The output driver stage is a Class B push-pull current drive coupled to the handpiece via a transformer and DC bias circuitry. Most magnetostrictive drives use a current drive because the magnetic field intensity is linearly proportional to the drive current—and, therefore, stroke—when the handpiece is properly biased.

Bandpass Filter (BPF)

The input bandpass filter consists of an instrumentation amplifier stage centered around U7 and an active two-pole filter centered around U12. The instrumentation amplifier has a common/differential mode loss pad

and RF filter consisting of R48, R49, R67, R68, C43, C46, and C53. The filter and pad pass the differential mode ultrasonic frequencies at about 16 dB of midband loss due to the large feedback voltage swings of up to 90 Vp-p of the 23 kHz handpiece/tip. The gain set resistor R66, selected by the analog switch U10C when the 35.75 kHz handpiece is connected, compensates for some of this loss for the 35.75 kHz circuit. The -3 dB point of the RF filter is at about 100 kHz to maximize RF losses at 500 kHz and above, and to minimize passband phase.

The active filter is an analog state-variable structure "universal active filter" IC. R95 and R96 determine the bandpass filter gain. R63, R75 and RV6 determine the center frequency for the 23 kHz circuit (or R62, R65, and RV7 for the 35.75 kHz circuit) as selected by the analog switches U10A, B, D, and U4C.

The BPF center frequency ensures that midband phase and gain are as flat as possible, but losses at the undesired longitudinal modes are maximized. For the 23 kHz circuit, the first undesired mode occurs at about 26 kHz; for the 35.75 kHz circuit, it occurs at approximately 43.8 kHz. Handpiece/tip length primarily determines this mode, although handpiece/tip diameter also affects it. Loss at these frequencies must come from two sources:

1. (Most obvious) BPF loss at these frequencies. However, the AGC loop gain may, in most instances, be sufficient to negate this loss.
2. Phase. If the phase is sufficient that the only operating point possible at this mode requires a very high gain, then this will not be a preferred mode.

AGC/Error Amplifier Circuit

The AGC function consists of the following components:

- A root mean square (RMS) to DC circuit centered around U23
- A handpiece (HP) amplitude input buffer centered around U22A
- An amplitude error amplifier centered around U22B
- A multiplier centered around U15.

C106 programs the RMS-to-DC conversion accuracy and low frequency pole. R146, R147, C102, and C103, together with the internal buffer amplifier of the IC, form a two-pole Sallen and Key low pass (LP) filter to remove high-frequency noise. A time constant (the product of C106 times the internal resistor in the RMS-to-DC converter) determines how fast the generator reacts and recovers from load and operating point condition changes.

The amplitude input buffer, U22A, filters (R100 and C73) and inverts the handpiece amplitude signal. The active rectifier circuit (CR16 and CR17) prevents positive valued amplitudes that could cause loop instability at the error amplifier.

The error amplifier, U22B, subtracts the RMS-to-DC signal from the handpiece amplitude signal. The residual signal is the loop gain value sent to the multiplier, U15. Two factors determine the steepness of the gain of this error amplifier:

- The input signal levels
- The minimum dynamic range required for the handpiece stroke levels under load and start-up conditions.

RV8 sets the gain of the amplifier, while RV9 sets the gain for the feedback signal levels.

The control function has an offset and a gain which limit the operating range capabilities (start-up and load) of the handpiece. At minimum level settings the control function must have a start-up gain of at least two times or greater the nominal error output. Under maximum load, the gain should be sufficiently large to allow stroke, even if the stroke is at reduced levels. If the gain is too large, however, a large enough feedback will force the error amplifier output to 0, whereby control is lost.

RV11 is for calibration purposes only.

Phase Compensator

The two-pole, active filter, U9, provides loop phase compensation. This is a Bessel filter characteristic implemented with a "low sensitivity" configuration. It is "low sensitivity" in that it has low operational amplifier (op-amp) slew rate and drive requirements, while component temperature and tolerance sensitivities also remain low. The phase for the 23 kHz circuit depends on the RC value of RV5, R52, and C41 selected by the analog switch U5A; the phase for the 35.75 kHz circuit depends on RV4, R300, and C41 selected by U5D. The nominal -3 dB point of the filter is 37.30 kHz.

The alignment of these filter poles with the BPF determines the amount of phase at the undesired longitudinal modes. Too little phase from the BPF makes it difficult to adjust these modes out; too much phase allows the center frequency to remain mis-adjusted and, therefore, may sacrifice mid-band gain flatness.

Driver Stage

The driver stage consists of the following components:

- A pre-amp, U1B
- A push-pull rectifier or phase splitter, U1A
- A positive half-cycle driver, U2B
- A negative half cycle driver U2A.

For the 23 kHz circuit, output stage gain depends on the combination of two gains:

- The pre-amp gain (R10 and R11)
- The phase-splitter gain (R19, R20, R24, and RV3).

For the 35.75 kHz circuit, output stage gain depends on RV2, selected by switches U5C and U5B.

The RUN_HPO signal from the machine control board via switch U4D enables the whole frequency loop.

U2A and U2B connect as non-inverting and inverting current sources via the feedback of the 0.25 Ohm resistors. Maximum current in the output transistors (20 amps peak) depends on the gain set by R13 and R15 for the positive half-cycle, and R41, R36, R18, and R17 for the negative half-cycle. Amplifier compensation for the positive half-cycles depends on R14 and C21; for the negative half cycles, R40, C35 and C15.

CR7 and CR2 protect output transistors Q15 and Q16 from the output transformer flyback; R38 protects the output transistors from open-circuit loading (like a short-circuit for voltage based designs). The output transformer is center tapped with a ratio of 1:4.6 for each half coil.

C10 provides AC coupling to the DC biased handpiece and its value is selected low enough to avoid resonant circuit interactions with the handpieces.

Feedback Signal

U13B, U11, U14, and U18 filter and convert the feedback signal to digital. The signal level depends on the gain of the amplifier U13B, R77, and R78.

Bias Circuitry

The bias circuit consists of the following items:

- A pass transistor switch, Q1
- Filter components L5 and C9
- CR1.

The filter prevents ultrasonic signal leakage from returning to the power supply, while CR1 acts as a free wheeling diode when Q1 is turned off.

Frequency Selection Circuitry

Handpiece interlock jumpers in the handpiece connectors enable frequency selection. A signal, filtered and "wired OR" for the HP_PRES signal, goes to the Machine Control board when either handpiece is present. The 23_PRES and $\overline{23\_PRES}$ signals select analog switches. The default frequency selection is the 35.75 kHz circuit.

Ultrasonics Board–Other Circuits

Audible Alert and Operation Indicator

A user adjustable tone indicates operation. U17A detects the presence of a signal and asserts the signal SPKR1. SPKR1 signal enables a piezo buzzer driver circuit that has a volume adjustment RV1. Alert tones override the operation indication in volume via SPKR2 signal, driven by the Machine Control board.

Valve Drivers

Pulse and hold circuits driven by the Machine Control board control the suction, syphon, and tissue release valves. U6, U3, and U19 provide drive current sinks. Resistor combinations determine the pulse and hold currents.

Power and Other Signal Connections

The +24 VAMP power supply provides circuit power for the Ultrasonics board. Sub-regulators U27 and U8 condition the power for the ±15 VUSB and +5 VUS.

The +24VX power supply also provides power to the valves, cooling fans, and pumps.

Cooling sensor, footswitch, suction pump level, irrigation pump level, and cooling pump level signals all pass from the Machine Control board to their respective devices by way of connectors on this board.

Dual 24 V Power Supply Board

The CUSA EXcel uses an OEM medical grade 600 watt power supply with an input voltage range of 88 to 264 VAC. The supply has two individually regulated 24 VDC, 12 amp outputs. This power supply is an enhanced leakage current version with earth leakage of less than 150 A. This supply is a UL recognized component for Canada and the U.S. and is CE labeled.

Checkout Procedures

In this section:

- Inspections
  - Footswitch
  - Power cord
- Power on verification
- Handpiece test (optional).

Inspections

When you have unpacked the console, and at regular intervals afterward, inspect the footswitch and the power cord.

Footswitch

1. Disconnect the footswitch from the console (rear panel).
2. Inspect the connector for damage or corrosion.
3. Inspect the footswitch for damage.
4. Inspect the cable for cuts, tears, or excessive compression.
5. Clean the footswitch and cable with a damp cloth and mild detergent.
6. Allow the footswitch to dry.
7. Connect the footswitch to the console (rear panel).

Power Cord

1. Unplug the system power cord from the wall receptacle.
2. Inspect for damage or corrosion. Ensure that the connector screws are tight.
3. Inspect the cord for damage.
4. Clean the power cord with a damp cloth and mild detergent.
5. Allow the power cord to dry.
6. Plug the power cord into a wall receptacle.

Power On Verification

1. Connect the footswitch.
2. Plug the system power cord into a wall receptacle.
3. Turn on (|) the AC Main Switch, located on the rear panel. The front panel indicators momentarily flash.
4. Turn on (|) the System Power Switch, located on the front panel.
5. The front panel indicators momentarily flash. The Handpiece and Alert indicators (red, left side of control panel) illuminate.

Handpiece Test (Optional)

To perform this test, you need a handpiece. Further, you must assemble the following components onto the handpiece:

- Tip
- O-rings
- Nosecone
- Flue.

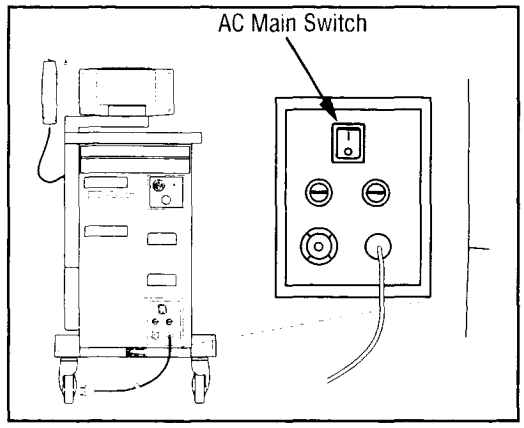
For complete information on assembling the handpiece, refer to Section 9, *Assembling the Handpiece in a Nonsterile Area*, in the ***CUSA EXcel System User's Guide***.

Notice

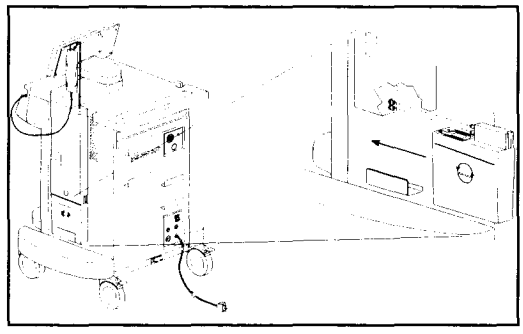
To avoid product damage, NEVER hold the handpiece in your hand while using the torque wrench to tighten or loosen the tip.

To test the handpiece, follow this procedure:

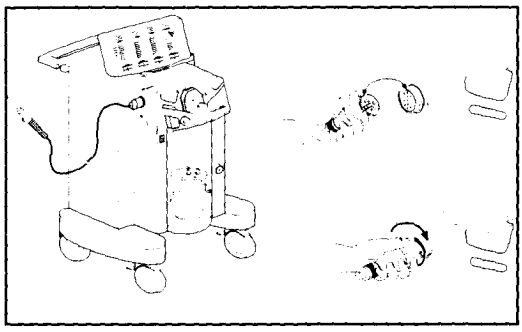
1. Plug the power cord into a wall receptacle.
2. Confirm that the AC main switch located on the rear panel is on (|).



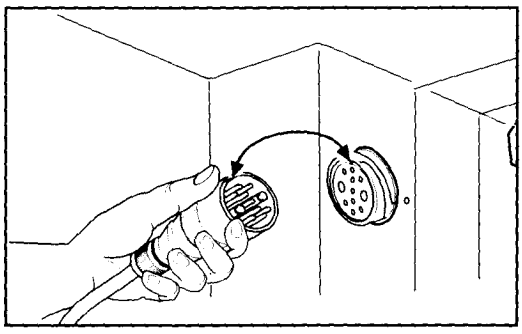
3. Fill the cooling water reservoir with 1000 cc distilled water.
4. Slide the cooling water reservoir into the slot on the console side panel until it snaps into place.



5. Connect the handpiece to the console.

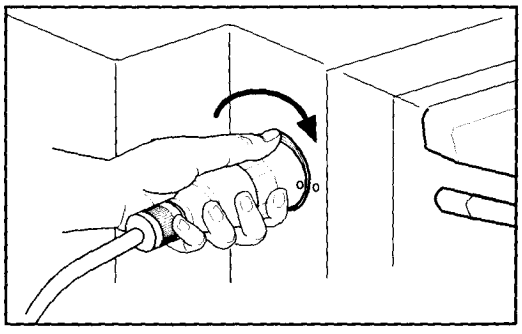


a. Line up the notch on the handpiece connector to the key in the receptacle (at the 12 o'clock position).

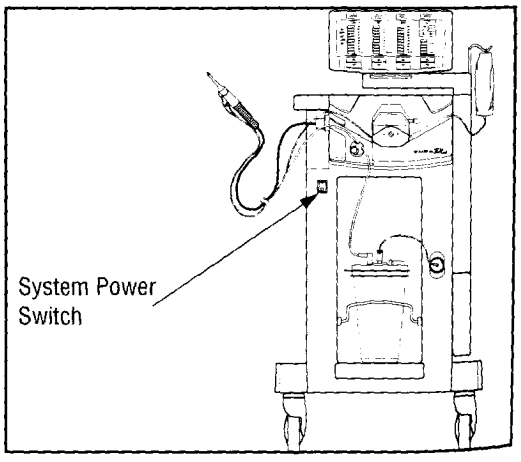


b. Gently push the handpiece connector onto the console connector.

c. Turn the connecting ring in the clockwise direction until the yellow dot on the handpiece aligns with the yellow dot on the console.



6. Turn on (|) the System Power Switch located on the front panel.

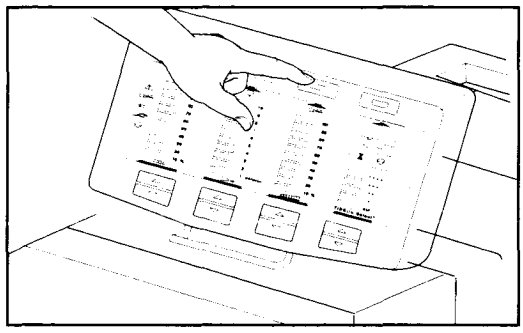


7. Wait for the Cooling Water and flashing Wait indicators (amber) to turn off (this indicates that the handpiece cooling water circuit is working properly). It usually takes about one minute.

Caution

Do not allow the handpiece tip to contact anyone or anything during tip activation. Contact may result in patient injury, user injury, or handpiece tip damage.

8. Push the Test button (orange box on a black button at the top of the amplitude display column) on the control panel.



The system automatically activates the handpiece at 100% vibration for 4 seconds. During the test, green LEDs in the amplitude display light up to 100% to show that the handpiece is working correctly.

9. Verify the following:

   - The Vibration alert (red) is off.
   - The LEDs light up to 100%.

   If you see no Vibration alert, and if the LEDs light up to 100%, the handpiece is working properly.

   If the Vibration alert illuminates, or if the LEDs do not light up to 100%, the handpiece is not working properly. This usually results from an improperly attached tip. Troubleshoot by

   - Removing and re-attaching the tip, then pushing the Test button again.
   - If the problem persists, attach a different handpiece.
   - If the problem still persists, contact the Valleylab Service Center nearest you.

10. If the test is successful, turn off the System Power Switch.
11. Wait for the handpiece cooling water to drain (the amber Wait and Cooling Water indicators go off), then disconnect the handpiece.

Maintaining the CUSA EXcel System

In this section:

- Recommended maintenance schedule
- Clean the CUSA EXcel console
- Clean the sterilizer case
- Maintain the handpiece
- Maintain the tip torquing set
- Store the CUSA EXcel system and accessories.

For Your Information

Routinely performing a few simple maintenance tasks keeps your CUSA EXcel system operating at maximum safety and performance levels. Biomedical Engineering at your facility should perform these tasks.

Recommended Maintenance Schedule

The following chart shows routine maintenance tasks, the equipment on which you perform them, and how often you perform each task. The term *months* refers to calendar months.

Table 9-1.
Routine maintenance tasks

Frequency	Equipment	Task
When used	Handpiece	Clean and wipe dry.
When used	Tip torquing set	Clean and wipe dry.
When used	CUSA console	Clean and wipe dry.
When used	Cooling water reservoir	Discard water from the reservoir.
When used	Footswitch	1. Discard the footswitch cover. 2. Clean the footswitch.
Every month or 20 procedures, whichever comes first	CUSA handpiece	Lubricate the handpiece connector o-rings.
Every 3 months, or every 12 to 15 procedures, whichever comes first	CUSA console	1. Fill the cooling water reservoir with a solution consisting of 100 cc of 70% alcohol and 900 cc of water. 2. Connect the handpiece, then turn on the system. 3. Allow the system to run a few cooling cycles to clean the interior tubing. 4. Turn off the system. 5. Discard the alcohol solution, then fill the reservoir with distilled water. 6. Turn on the system, and allow it to cycle the water to clean the alcohol solution out of the tubing. 7. Turn off the system. 8. Discard water from the reservoir.
Every 6 months or when the surgeon notices a lack of suction	CUSA console	Replace the contamination guard. Write either the installation date or the expiration date on the new guard.
Every 6 months or 100 procedures, whichever comes first	CUSA handpiece	Replace the handpiece connector o-rings.

Frequency	Equipment	Task
Once a year	Tip torquing wrench	Check the torque.
Once a year	CUSA console	Contact a Valleylab service representative to replace the cooling water pump tubing.

Clean the CUSA EXcel Console

You cannot sterilize the CUSA console, but you can clean it, disinfect it, or both. Use a mild cleaning solution or disinfectant and a damp cloth.

Warning

Electric Shock Hazard Always unplug the CUSA system before cleaning.

Notice

Do not rub, press, or touch any panels with solvents; caustic, corrosive, or abrasive cleaning or disinfectant compounds; or other materials that could scratch the panels. Do not use a betadine-based solution; it will cause discoloration.

Do not allow fluids to enter the chassis.

1. Unplug the unit power cord from the wall receptacle.
2. Using standard procedures for your facility, thoroughly wipe all surfaces and cords with a cleaning solution and disinfectant.
3. Make sure that the surface is completely dry before using the system again.

Clean the Sterilizer Case

Use a neutral detergent to clean the sterilizer case.

Notice

Do not clean the sterilizer case with abrasives. Product damage will result.

Maintain the Handpiece

Maintaining the handpiece involves cleaning the handpiece, lubricating the handpiece connector o-rings with a high viscosity lubricant such as silicone grease, or replacing the handpiece connector o-rings. If a problem develops, you may also need to have the handpiece recalibrated.

Clean the Handpiece

Items needed: Soft cloths (one moist, one dry), swab or pipe cleaner, mild cleansing solution, and rinse water.

Notice

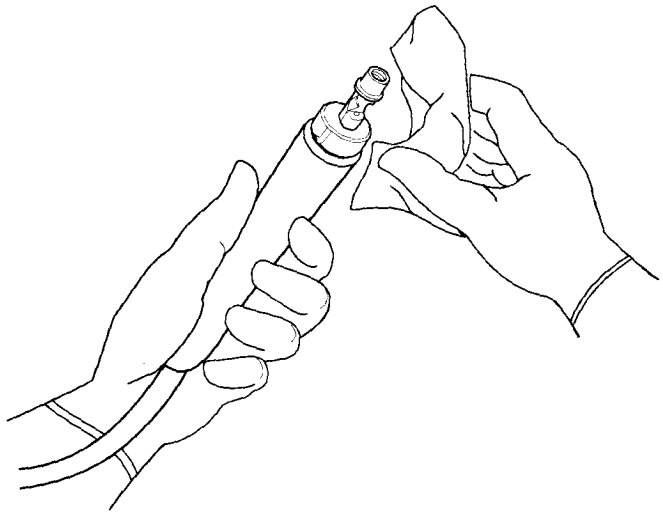
Product damage will result if you do not follow these notices when cleaning the handpiece:

- Do not immerse the handpiece cable electrical connector in liquid.
- Do not use ultrasonic or automated cleaners.
- Do not use chlorinated substances such as bleach solution.
- Do not clean the handpiece with abrasives such as Ajax, Comet, or steel wool.

Procedure:

1. Using a soft cloth, manually clean the handpiece, handpiece cable, and standard nosecone with a mild cleansing solution (neutral detergent) or blood dissolving detergent according to hospital policy.
2. Using a swab or pipe cleaner, manually clean the internal threads and suction port of the connecting body.
3. Using a soft cloth, manually clean the internal threads and face of the connecting body. Refer to Figure 9-1.

Figure 9-1.
Cleaning the handpiece with a soft cloth



4. Rinse the handpiece cable, handpiece housing, connecting body, and nosecone thoroughly with water.
5. Using a soft cloth, dry the handpiece cable, handpiece housing, connecting body, and standard nosecone.

Lubricate the Handpiece Connector O-Rings

Keeping the o-rings lubricated prevents them from drying out and cracking, which may cause handpiece cooling problems.

Items needed: A high viscosity lubricant such as silicone grease.

Items to be lubricated: The four o-rings on the handpiece connector water prongs.

Replace the Handpiece Connector O-Rings

Regularly replacing the o-rings prevents excessive wear, which may result in handpiece cooling problems.

Items needed: O-Ring maintenance kit (Part Number 260-650-000), which includes o-rings, an insertion tool, and instructions.

Items to be replaced: The four o-rings on the handpiece connector water prongs.

Refer to Figure 9-2.

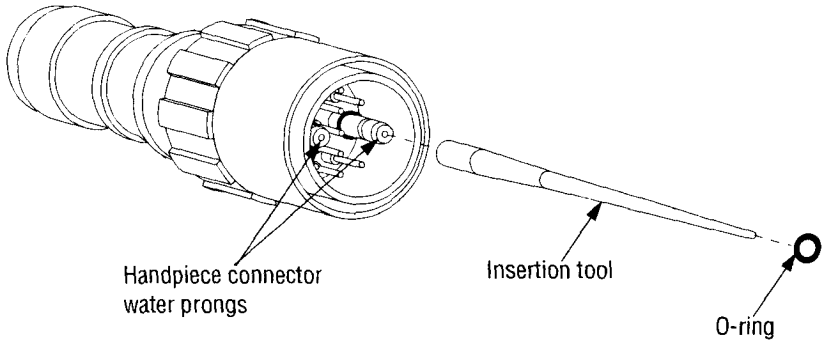


Figure 9-2.
Replacing the handpiece connector o-rings

Recalibrate the Handpiece

Handpieces for the CUSA EXcel system do not need recalibration unless a problem develops. If this happens, contact Valleylab to arrange returning the handpiece for service. (Refer to *Return Equipment for Service* in Section 13, *Repair Policy.*)

Maintain the Tip Torquing Set

Clean the Tip Torquing Set

Notice

Product damage will result if you do not follow these notices when cleaning the Tip Torquing Set.

- Do not use ultrasonic or automatic washers.
- Do not autoclave.
- Do not use chlorinated substances such as bleach solution.
- Do not clean with abrasives such as Ajax, Comet, or steel wool.

Items Needed

Detergent, two soft cloths, and rinse water.

Procedure:

1. Using a soft cloth and a water and detergent combination, manually clean the tip torquing base and the torque wrench.
2. Rinse the tip torquing set thoroughly with water.
3. Using a soft cloth, dry the tip torquing set.

Check the Torque on the Tip Torquing Wrench

A biomedical engineer or a Valleylab service representative should check the torque on the tip torquing wrench.

Tools Needed

- Torque indicating wrench
- 7/32 in. hex socket
- 9/32 in. hex socket.

Procedure:

1. Attach the socket to the torque indicating wrench.
2. Clamp the torque indicating wrench handle in a vise.
3. On the torque indicating wrench, adjust the scale under the indicator needle to zero.
4. Set the peak indicating needle on the torque indicating wrench to zero.
5. Place the green end of the torque wrench from the tip torquing set on the 9/32 in. hex socket.
6. Rotate the tip torquing wrench clockwise until you feel and hear a click.
7. Rotate the tip torquing wrench clockwise until you feel and hear a second click.

8. Read and record the peak torque.
9. Repeat steps three through eight for a total of three times.
10. Repeat the process on the blue end of the tip torquing wrench and the 7/32 in. hex socket.
11. All values must be in the following ranges:

Table 9-2.
Torque values for the torque wrench

Handpiece frequency	Range (inch-pounds)
23 kHz (green)	55 to 70
36 kHz (blue)	20 to 32

If the values are higher or lower, send the wrench to Valleylab for recalibration.

Store the CUSA EXcel System and Accessories

CUSA Console

Drain all liquids. Store the CUSA system in a low traffic area that is free of dirt, blood, water, and other contaminants. Store the system at an ambient temperature between -34° C and 65° C.

Handpiece

Drain all liquids. Store the handpiece in the sterilizer case according to your facility's policy.

Store the handpiece at an ambient temperature between -34° C and 65° C.

Footswitch

If you have attached the footswitch to the console, you do not need to disconnect it except for maintenance or service. When you are not using the CUSA system, store the footswitch in the storage compartment in the rear of the console.

CEM Nosecone

The CEM nosecone is a sterile, single-use item. Store unopened packages; discard used CEM nosecones.

Troubleshooting

In this section:

- Troubleshooting safety
- User troubleshooting
  - Responding to alerts
  - General troubleshooting
- Engineer troubleshooting
  - Guidelines
  - Flow Charts.

For Your Information

Two types of troubleshooting procedure are available for the CUSA EXcel system:

- User troubleshooting—these procedures involve conditions that may occur before or during the normal course of surgery. They are easy to diagnose and to fix. Refer to the user oriented troubleshooting tables in this section or Section 13, *Troubleshooting the CUSA EXcel System,* in the ***CUSA EXcel System User's Guide.***
- Engineer troubleshooting—these procedures involve conditions that may occur within subsystems. They require service from a biomedical engineer or Valleylab service representative. Refer to the technical troubleshooting flow charts in this section.

This section repeats the user troubleshooting tables presented in Section 13, *Troubleshooting the CUSA EXcel System*, in the ***CUSA EXcel System User's Guide***. It then presents engineer troubleshooting, describing a visual inspection of the CUSA EXcel system (to detect any obvious problems) and including flow charts for troubleshooting the system as a whole and each of its subsystems.

Troubleshooting Safety

It is important that you read and understand the following warnings and notices:

Warning

Electric Shock Hazard Do not touch any exposed wiring or conductive surface while the system is disassembled and energized. Never wear a grounding strap when working on an energized system.

Electric Shock Hazard Take appropriate precautions (such as the use of isolated tools and equipment; use of the "one hand rule," etc.) when taking measurements or troubleshooting the system.

Notice

Electrostatic Sensitive Devices This unit contains electrostatic sensitive components. When repairing the system, work at a static control workstation. Wear a grounding strap when handling electrostatic sensitive components. Handle circuit boards by their nonconductive edges. Use an antistatic container for transport of electrostatic sensitive components and circuit boards.

User Troubleshooting

The CUSA EXcel system runs nearly trouble free. However, on occasion, a problem may arise. This section describes some conditions that may occur before or during the normal course of surgery. They are easy to diagnose and to fix.

Warning

Do not activate vibration or the CEM handswitching nosecone while using the tip cleaner. Tip damage, user injury, electrical shock, or any combination of these effects may occur.

Responding to Alerts

Alert	Causes	Recommended Action
Footswitch	Footswitch cable not properly connected to console	Connect the footswitch to the console (rear panel). Turn the connector until you feel it lock into place. If the alert persists after you connect the footswitch to the console, call Valleylab for assistance.
Handpiece	Handpiece cable not properly connected to console	Connect the handpiece to the console. Twist the handpiece connector clockwise until it locks into place, then verify that the yellow dots align. If the alert persists after you connect the handpiece to the console, call Valleylab for assistance.
	Using a CUSA 200 system 23 kHz handpiece (black connector)	Connect a CUSA EXcel 23 kHz handpiece (green connector) or 36 kHz handpiece (blue connector).
Cooling Water—continuously on	Not enough distilled water in the cooling water reservoir	Add distilled water to the cooling water reservoir to the fill line.
	Cooling water reservoir not properly seated	Re-seat the cooling water reservoir in the console.
	A pinch or kink in the handpiece cable	Remove the pinch or kink in the cable.
	Handpiece cable not properly connected to console	Connect the handpiece to the console. Twist the handpiece connector clockwise until it locks into place, then verify that the yellow dots align.
	Damaged, misaligned, or missing o-rings in the handpiece connector	Connect a new handpiece to the CUSA EXcel system, and test it for proper function. If the alert persists after you connect the new handpiece to the console, call Valleylab for assistance.
Cooling Water—flashing on and off	Possible air bubble in the handpiece cooling system	The CUSA EXcel system corrects this condition. However, if the Cooling Water alert remains lit, refer to the condition immediately before this one: *Cooling Water—continuously on.*
	A pinch or kink in the handpiece cable	Remove the pinch or kink in the cable.

Alert	Causes	Recommended Action
Vibration—In Test mode only	Tip loose due to incorrect assembly	Testing before sterilization: **1.** Use the tip torquing base and wrench to tighten the tip. **2.** Test the tip. **3.** Sterilize the handpiece.
		Testing after sterilization when tip assembled in a nonsterile area: **1.** Remove the handpiece from the sterile field. **2.** Use the tip torquing base and wrench to tighten the tip. **3.** Test the tip. **4.** Sterilize the handpiece.
		Testing after sterile tip assembled to handpiece on the sterile field: **1.** Use the sterilizable torque base and a disposable sterile wrench to tighten the tip. (Refer to the *Supplement, Assembling or Changing Tips on the Sterile Field*, which is part 2 of the ***CUSA EXcel System User's Guide***.) **2.** Test the tip.
	Tip contacting another object	Remove the contact with any other object.

Alert	Causes	Recommended Action
Vibration—In Test mode only—continued	Blocked tip	1. Verify that the manifold suction tube connects properly to the nosecone by disconnecting, then reconnecting, the tubing and its clip. 2. Use the tip cleaner to dislodge the blockage in the tip. Continue to push the tip cleaner into the tip until the cleaner becomes visible in the tubing. 3. When you have cleared the blockage, verify again that the manifold suction tube connects properly to the nosecone. 4. If the tip remains blocked, disconnect the manifold suction tube connector from the nosecone. Use the tip cleaner to dislodge blockage from the tubing, then reconnect the tubing to the nosecone. 5. Immerse the handpiece tip in sterile irrigation fluid briefly. This may clear the suction tubing.
	Damaged or cracked tip	Testing before sterilization: 1. Use the tip torquing base and wrench to replace the tip. 2. Test the tip. 3. Sterilize the handpiece.
		Testing after sterilization when tip assembled in a nonsterile area: 1. Remove the handpiece from the sterile field. 2. Use the tip torquing base and wrench to replace the tip. 3. Test the tip. 4. Sterilize the handpiece.
		Testing after sterile tip assembled to handpiece on the sterile field: 1. Use the sterilizable torque base and a disposable sterile wrench to replace the tip. (Refer to the *Supplement, Assembling or Changing Tips on the Sterile Field*, which is part 2 of the ***CUSA EXcel System User's Guide***.) 2. Test the tip.

Alert	Causes	Recommended Action
Vibration—In Test mode only—continued	Damaged handpiece	1. Connect a new handpiece to the CUSA EXcel console and test it. 2. If the new handpiece corrects the problem, • Verify that the previous handpiece is correctly assembled, and • If it was correctly assembled, send it to Valleylab for repair. If the problem persists after you replace the handpiece, call Valleylab for assistance.

General Troubleshooting

Condition	Causes	Recommended Action
No power at the console	AC Main Switch (on the rear panel) off	Turn on the AC Main Switch (on the rear panel).
	System Power Switch (front of console) off	Turn on the System Power Switch (on the front of the console).
	Power cord not plugged in	Plug the power cord into the wall receptacle.
	Wall receptacle has no power available	Try another wall receptacle, or check the operating room circuit breakers.
Power interruption to the console	Power cord becomes unplugged	1. Turn off the System Power Switch (on the front of the console). 2. Plug the power cord into the wall receptacle. 3. When power is restored, turn on the System Power Switch. 4. When the Wait light (flashing) turns off, press the Prime button to make sure the irrigation system is ready to use. 5. Adjust the Aspiration, Irrigation, Amplitude, and TISSUE Select settings. 6. Push the Status button to change to Run mode.

Condition	Causes	Recommended Action
Power interruption in the operating room	Facility power loss	1. Turn off the System Power Switch (on the front of the console). 2. When power is restored, turn on the System Power Switch. 3. When the Wait light (flashing) turns off, press the Prime button to make sure the irrigation system is ready to use. 4. Adjust the Aspiration, Irrigation, Amplitude, and TISSUE Select settings. 5. Push the Status button to change to Run mode.
No irrigation flow from the handpiece flue; the handpiece tip gets hot	I.V. administration set roller clamp closed	Open the roller clamp.
	Irrigation tubing not routed properly through irrigation pump	Route the irrigation tubing properly through the irrigation pump.
	Manifold irrigation tubing not connected to the handpiece flue tubing	Connect the Luer fitting.
	Not enough time set at Prime to allow fluid to pass through the irrigation tubing	Press the Prime button, allowing time for irrigation fluid to drip from the tip.
	Irrigation tubing pinched or kinked	Remove the pinch or kink from the tubing.
	I.V. bag empty	Replace the I.V. bag. Note: For long periods of nonuse, switch the CUSA EXcel console to Standby mode to conserve irrigation solution.
	Irrigation pump not turning	Call Valleylab for assistance.
Excessive misting at the handpiece tip	Flue not lined up with tip pre-aspiration holes	Adjust the flue position to line up with the pre-aspiration holes in the tip.
	Too much irrigation	Reduce the irrigation rate.
	Low suction setting on the control panel	Increase the setting.
	Low or no suction due to suction tubing improperly connected to handpiece	Verify that the manifold suction tube connects properly to the nosecone by disconnecting, then reconnecting, the tubing and its clip.

Condition	Causes	Recommended Action
Excessive misting at the handpiece tip—continued	Blocked tip	1. Verify that the manifold suction tube connects properly to the nosecone by disconnecting, then reconnecting, the tubing and its clip. 2. Use the tip cleaner to dislodge the blockage in the tip. Continue to push the tip cleaner into the tip until the cleaner becomes visible in the tubing. 3. When you have cleared the blockage, verify again that the manifold suction tube connects properly to the nosecone. 4. If the suction remains low, disconnect the manifold suction tube connector from the nosecone. Use the tip cleaner to dislodge blockage from the tubing, then reconnect the tubing to the nosecone. 5. Immerse the handpiece tip in sterile irrigation fluid briefly. This may clear the blockage.
	Blockage in the suction tubing at the handpiece	1. Immerse the handpiece tip in sterile irrigation fluid briefly. This may clear the suction tubing. 2. Press the Status button to change to Standby mode. Use the sterile tip cleaner to clean out the tip, then put the tip in irrigating fluid to flush the tubing. 3. As necessary, disconnect, clean, and reconnect the suction tubing connector at the handpiece.
	A pinch or kink in the suction tubing	Straighten the tubing to remove a kink, or remove anything that might pinch the tube.
	A blockage in the suction tubing between the handpiece and the suction canister	1. Examine the suction tubing along its entire length for a blockage. 2. Squeeze the blocked area to loosen it. 3. Immerse the handpiece tip in sterile irrigation fluid briefly. This may clear the blockage.
	Suction canister full	Replace the suction canister.

Condition	Causes	Recommended Action
Excessive misting at the handpiece tip—continued	Suction connections at the suction canister not seated properly	1. Remove any unused suction canister "elbow" connectors. 2. Reseat all connections.
	Open port(s) on the suction canister	Close any open ports on the suction canister.
	Suction canister improperly connected	Refer to the canister manufacturer's instructions for connecting the canister.
	Inside of the contamination guard wet and blocked	1. Disconnect the contamination guard fitting from the suction canister tubing. If you feel no suction at the end of the contamination guard fitting, the guard is blocked. 2. Replace the contamination guard.
	Problem at the CUSA EXcel console suction port	Remove the contamination guard and put a finger in the suction system port. If you feel no suction, call Valleylab for assistance.
	Suction pinch valve working improperly	Check the Lap mode indicator. • If Lap mode is off, in Run mode the pinch valve should be open. • If Lap mode is on, in Run mode the pinch valve should be open ***only*** when you activate vibration. If these conditions do not exist, call Valleylab for assistance.
No green LEDs (other than setpoints) illuminate when you activate vibration	System in Standby mode	Press the Status button to switch the system to Run mode.

Condition	Causes	Recommended Action
Little or no vibration or fragmentation (Amplitude LEDs may illuminate well below setpoint)	Excessive tip/tissue pressure (stalling tip)	1. Verify that console settings are at desired levels. 2. Remove the tip from contact with tissue, then reactivate vibration. Note: When first activating vibration, make sure that there is no tip/tissue pressure.
	Blocked tip	1. Verify that the manifold suction tube connects properly to the nosecone by disconnecting, then reconnecting, the tubing and its clip. 2. Use the tip cleaner to dislodge the blockage in the tip. Continue to push the tip cleaner into the tip until the cleaner becomes visible in the tubing. 3. When you have cleared the blockage, verify again that the manifold suction tube connects properly to the nosecone. 4. If the tip remains blocked, disconnect the manifold suction tube connector from the nosecone. Use the tip cleaner to dislodge blockage from the tubing, then reconnect the tubing to the nosecone. 5. Immerse the handpiece tip in sterile irrigation fluid briefly. This may clear the suction tubing.
	Incorrect flue installed	Install the correct flue.

Condition	Causes	Recommended Action
Little or no vibration or fragmentation (Amplitude LEDs may illuminate well below setpoint)—continued	Tip loose due to improper assembly	**1.** Press the Status button to place the system in Standby mode. **2.** Press the Test button to test the handpiece and tip. **3.** If the Vibration alert activates, do one of the following: If tip assembled in a nonsterile area: **a.** Remove the handpiece from the sterile field. **b.** Use the tip torquing base and wrench to tighten the tip. **c.** Test the tip. **d.** Sterilize the handpiece. If sterile tip assembled to handpiece on the sterile field: **a.** Use the sterilizable torque base and a disposable sterile wrench to tighten the tip. (Refer to the *Supplement, Assembling or Changing Tips on the Sterile Field,* which is part 2 of the ***CUSA EXcel System User's Guide.***) **b.** Test the tip.

Condition	Causes	Recommended Action
Little or no vibration or fragmentation (Amplitude LEDs may illuminate well below setpoint)—continued	Damaged or cracked tip	1. Press the Status button to place the system in Standby mode. 2. Press the Test button to test the handpiece and tip. 3. If the Vibration alert activates, do one of the following: If tip assembled in a nonsterile area: a. Remove the handpiece from the sterile field. b. Use the tip torquing base and wrench to replace the tip. c. Test the tip. d. Sterilize the handpiece. If sterile tip assembled to handpiece on the sterile field: a. Use the sterilizable torque base and a disposable sterile wrench to replace the tip. (Refer to the *Supplement, Assembling or Changing Tips on the Sterile Field*, which is part 2 of the ***CUSA EXcel System User's Guide***.) b. Test the tip.
	Damaged handpiece	1. Connect a new handpiece to the CUSA EXcel console and test it. 2. If the new handpiece corrects the problem, • Verify that the previous handpiece is correctly assembled, and • If it was correctly assembled, send it to Valleylab for repair. If the problem persists after you replace the handpiece, call Valleylab for assistance.
Suction tube won't assemble correctly to handpiece nosecone	Nosecone not assembled to handpiece correctly	Align the dot on the nosecone with the dot on the handpiece.
	Transducer is twisted inside handpiece housing	Replace the handpiece.

Condition	Causes	Recommended Action
Low suction at the handpiece tip	Low suction setting on the control panel	Increase the setting.
	System inadvertently in Lap mode	Turn off the Lap mode by pressing the Lap mode button.
	Suction tubing improperly connected to handpiece	Verify that the manifold suction tube connects properly to the nosecone by disconnecting, then reconnecting, the tubing and its clip.
	Blocked tip	1. Verify that the manifold suction tube connects properly to the nosecone by disconnecting, then reconnecting, the tubing and its clip. 2. Use the tip cleaner to dislodge the blockage in the tip. Continue to push the tip cleaner into the tip until the cleaner becomes visible in the tubing. 3. When you have cleared the blockage, verify that the manifold suction tube connects properly to the nosecone. 4. If the suction remains low, disconnect the manifold suction tube connector from the nosecone. Use the tip cleaner to dislodge blockage from the tubing, then reconnect the tubing to the nosecone. 5. Immerse the handpiece tip in sterile irrigation fluid briefly. This may clear the blockage.
	Blockage in the suction tubing at the handpiece	1. Immerse the handpiece tip in sterile irrigation fluid briefly. This may clear the suction tubing. 2. Press the Status button to change to Standby mode. Use the sterile tip cleaner to clean out the tip, then put the tip in irrigating fluid to flush the tubing. 3. As necessary, disconnect, clean, and reconnect the suction tubing connector at the handpiece.
	A pinch or kink in the suction tubing	Straighten the tubing to remove a kink, or remove anything that might pinch the tube.

Condition	Causes	Recommended Action
Low suction at the handpiece tip—continued	A blockage in the suction tubing between the handpiece and the suction canister	1. Examine the suction tubing along its entire length for a blockage. 2. Squeeze the blocked area to loosen it. 3. Immerse the handpiece tip in sterile irrigation fluid briefly. This may clear the blockage.
	Suction canister full	Replace the suction canister.
	Suction connections at the suction canister not seated properly	1. Remove any unused suction canister "elbow" connectors. 2. Reseat all connections.
	Open port(s) on the suction canister	Close any open ports on the suction canister.
	Suction canister improperly connected	Refer to the canister manufacturer's instructions for connecting the canister.
	Inside of the contamination guard wet, blocked, or both	1. Disconnect the contamination guard fitting from the suction canister tubing. If you feel no suction at the end of the contamination guard fitting, the guard is blocked. 2. Replace the contamination guard.
	Problem at the CUSA EXcel console suction port	Remove the contamination guard and put a finger in the suction system port. If you feel no suction, call Valleylab for assistance.
	Suction pinch valve working improperly	Check the Lap mode indicator. • If Lap mode is off, in Run mode the pinch valve should be open. • If Lap mode is on, in Run mode the pinch valve should be open ***only*** when you activate vibration. If these conditions do not exist, call Valleylab for assistance.
The handpiece gets hot	Surgeon holding handpiece at tip and flue	Hold the handpiece at the nosecone.
	Handpiece damage due to tip torquing without the torque base	Replace the handpiece.
The nosecone is loose	Large o-ring not installed correctly, or missing	Install the large o-ring in the proper position on the handpiece.
	Nosecone worn	Replace the nosecone.

Engineer Troubleshooting

Guidelines

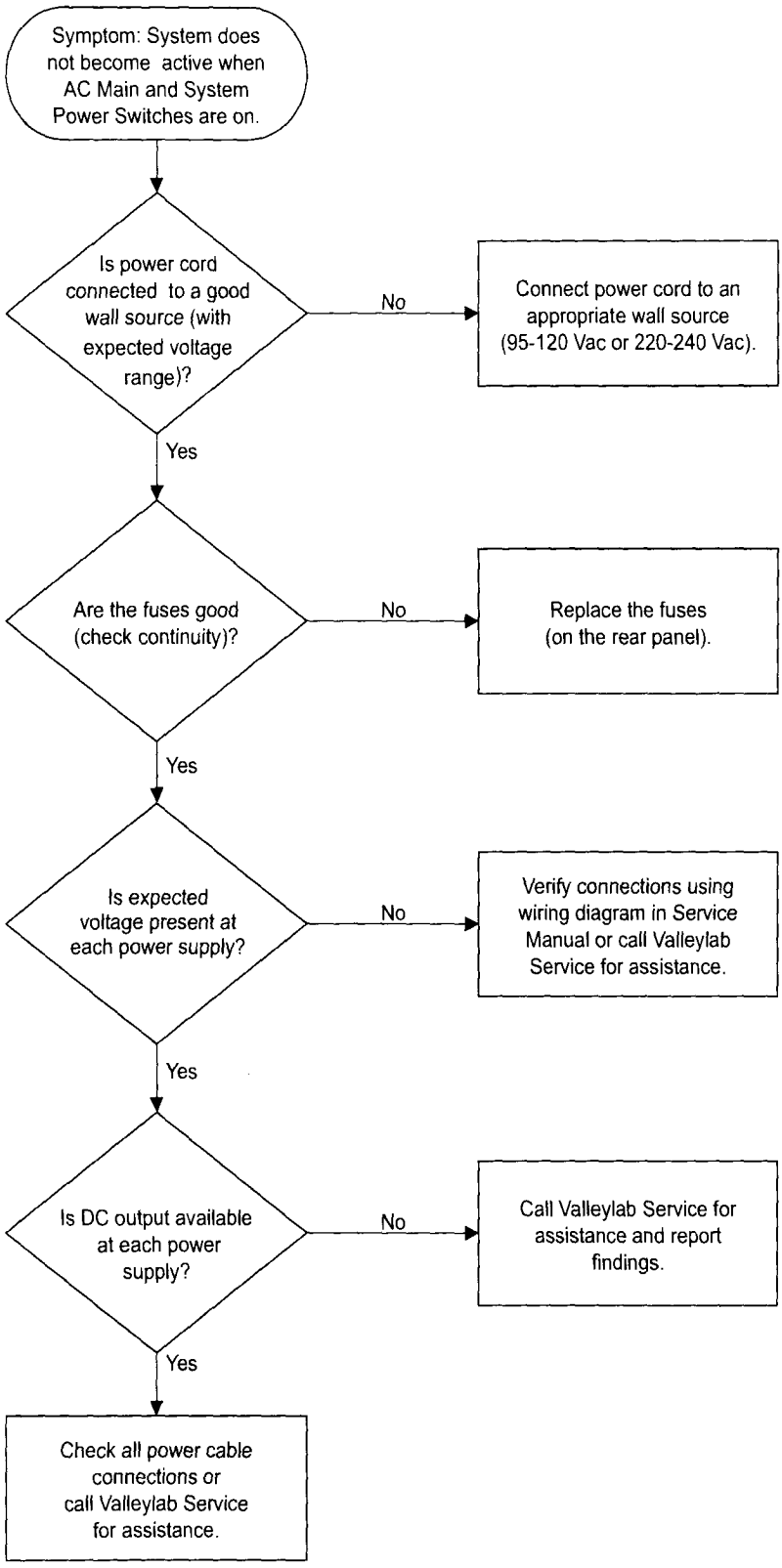
1. Perform the user troubleshooting procedures.
2. Perform a visual inspection of the system.
3. Look for obvious causes of the malfunction first, such as loose connections, broken wires, or discolored/burned components.
4. If a single function is not working, concentrate on that circuit or that part of the system.
5. If several symptoms are present, locate a circuit that is common to all affected functions. If the solution is not obvious, check the power supply circuits first.

Flowcharts

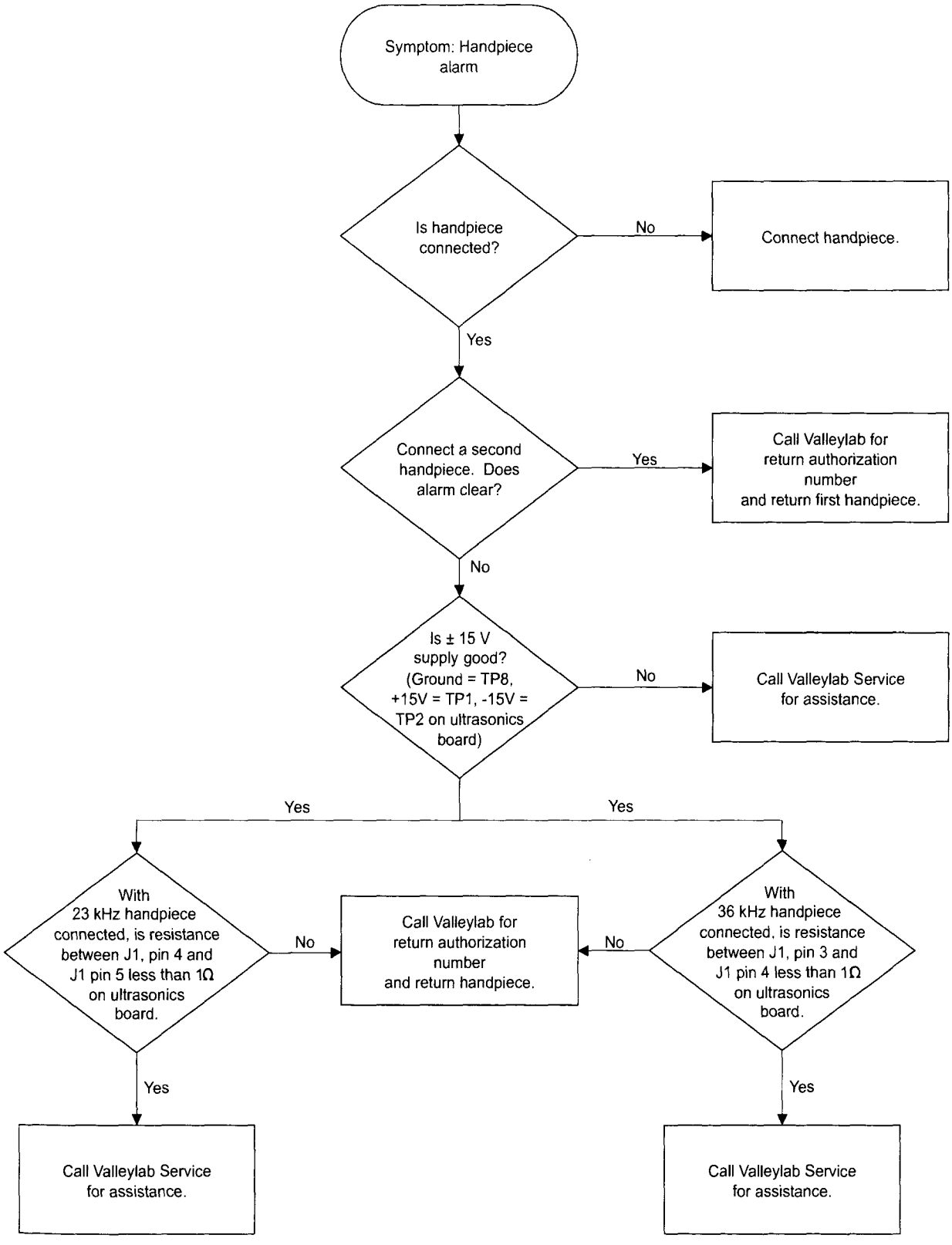
The following flowcharts present troubleshooting procedures:

- No power
- Handpiece alarm
- Footswitch alarm
- Cooling water alarm
- Low suction
- Low irrigation
- Vibration alarm.

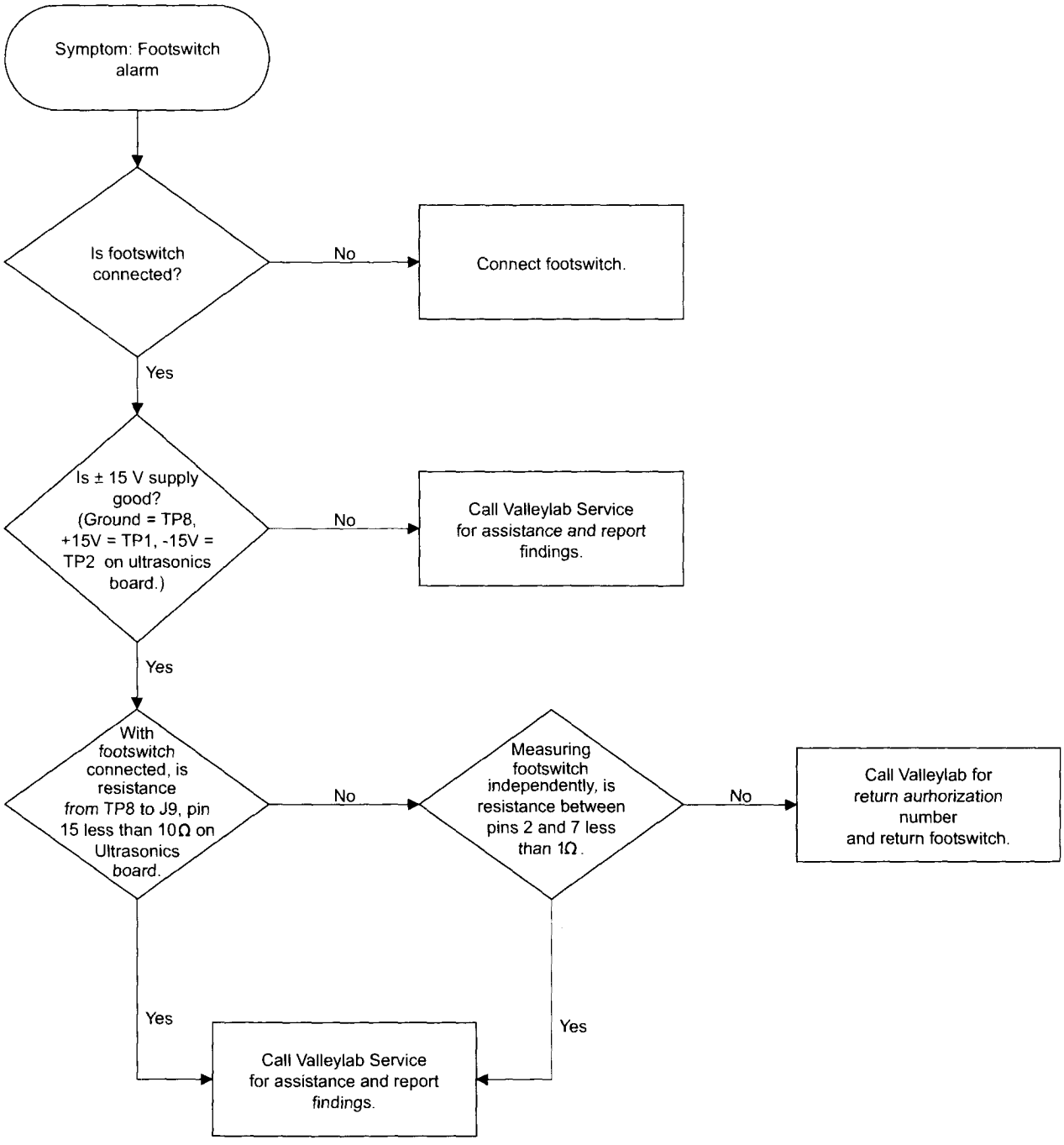
No Power


Symptom: System does not become active when AC Main and System Power Switches are on.
Is power cord connected to a good wall source (with expected voltage range)?
No
Connect power cord to an appropriate wall source (95-120 Vac or 220-240 Vac).
Yes
Are the fuses good (check continuity)?
No
Replace the fuses (on the rear panel).
Yes
Is expected voltage present at each power supply?
No
Verify connections using wiring diagram in Service Manual or call Valleylab Service for assistance.
Yes
Is DC output available at each power supply?
No
Call Valleylab Service for assistance and report findings.
Yes
Check all power cable connections or call Valleylab Service for assistance.

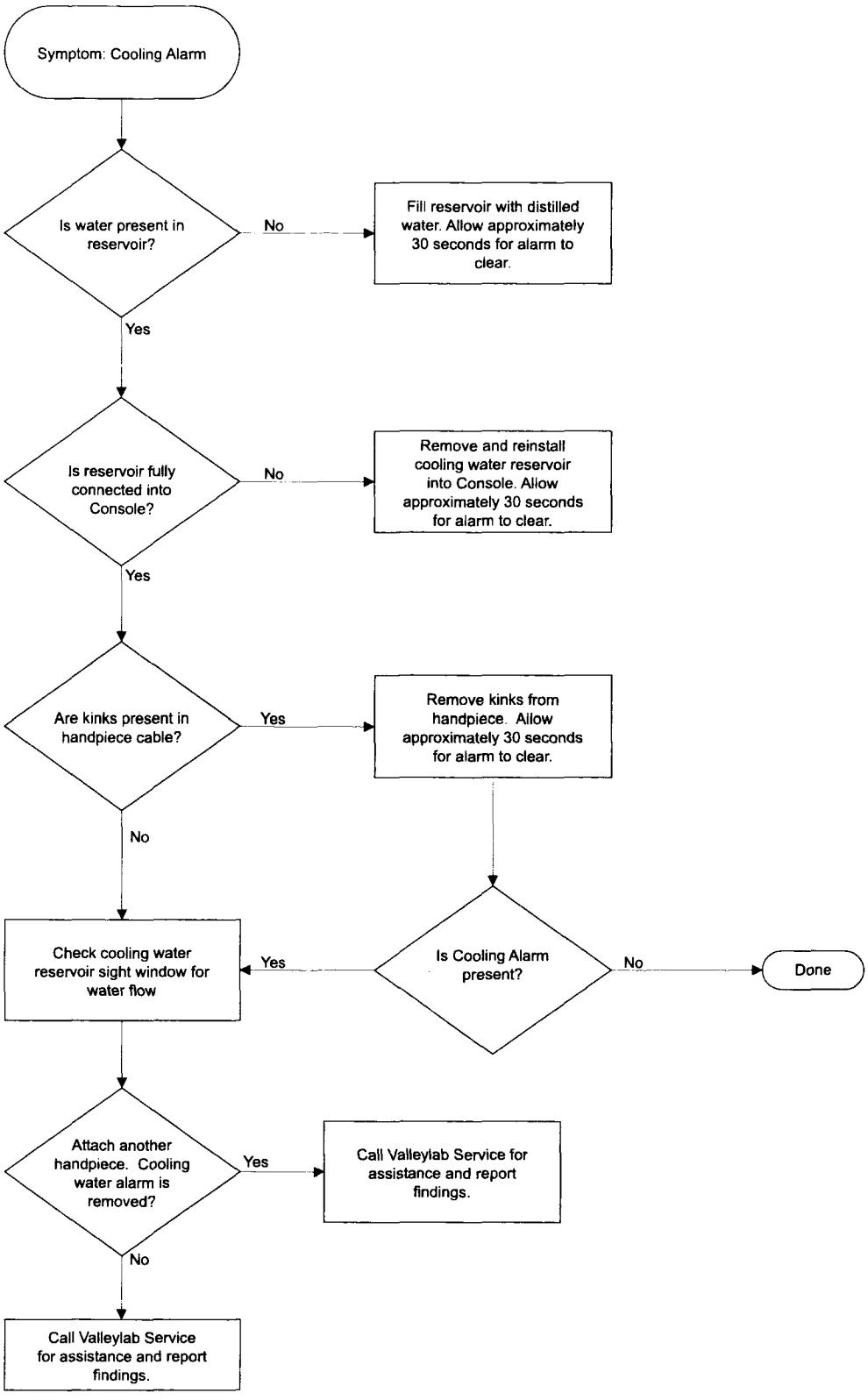
Handpiece Alarm


Symptom: Handpiece alarm
Is handpiece connected?
No
Connect handpiece.
Yes
Connect a second handpiece. Does alarm clear?
Yes
Call Valleylab for return authorization number and return first handpiece.
No
Is ± 15 V supply good? (Ground = TP8, +15V = TP1, -15V = TP2 on ultrasonics board)
No
Call Valleylab Service for assistance.
Yes
Yes
With 23 kHz handpiece connected, is resistance between J1, pin 4 and J1 pin 5 less than 1Ω on ultrasonics board.
No
Call Valleylab for return authorization number and return handpiece.
No
With 36 kHz handpiece connected, is resistance between J1, pin 3 and J1 pin 4 less than 1Ω on ultrasonics board.
Yes
Yes
Call Valleylab Service for assistance.
Call Valleylab Service for assistance.

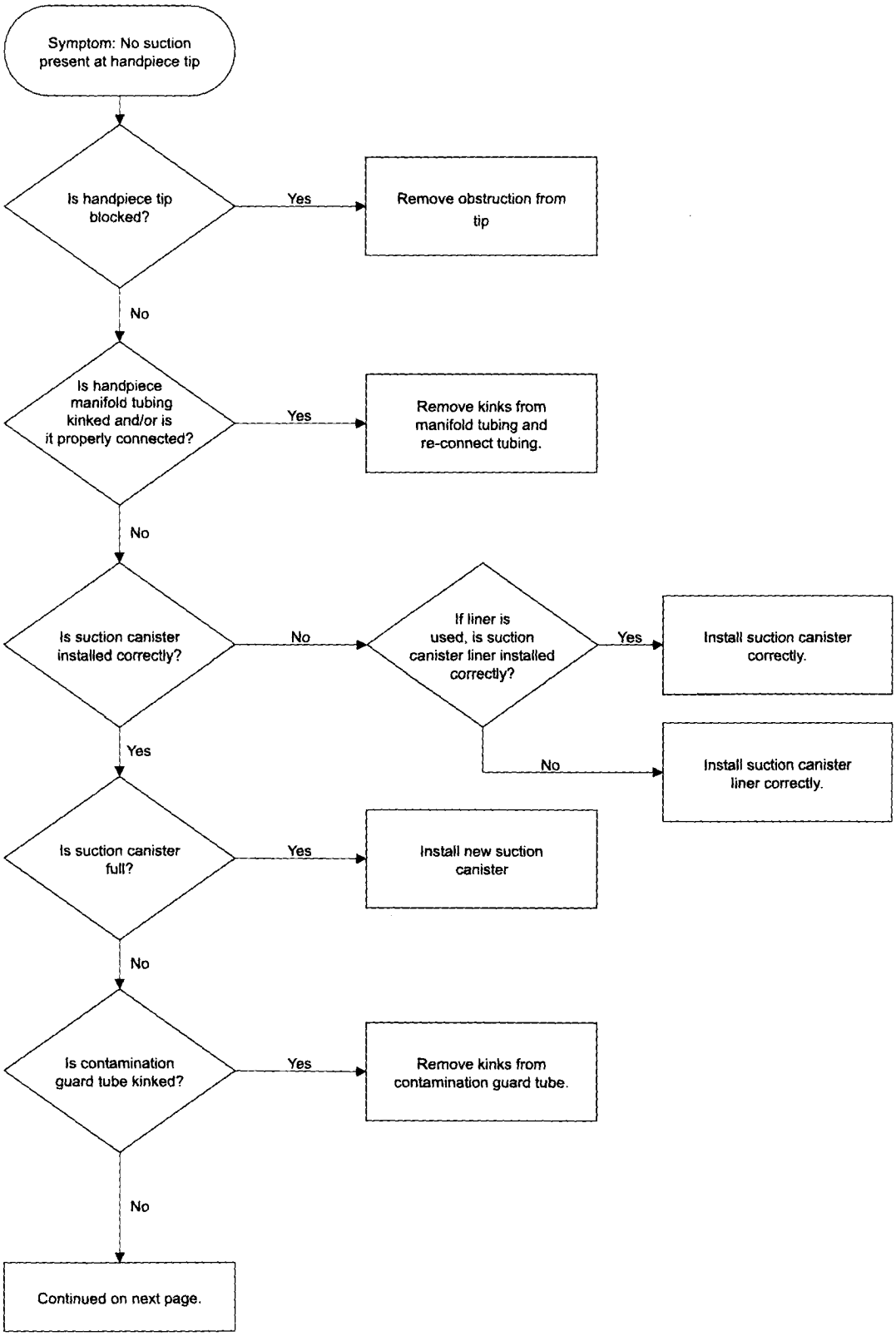
Footswitch Alarm

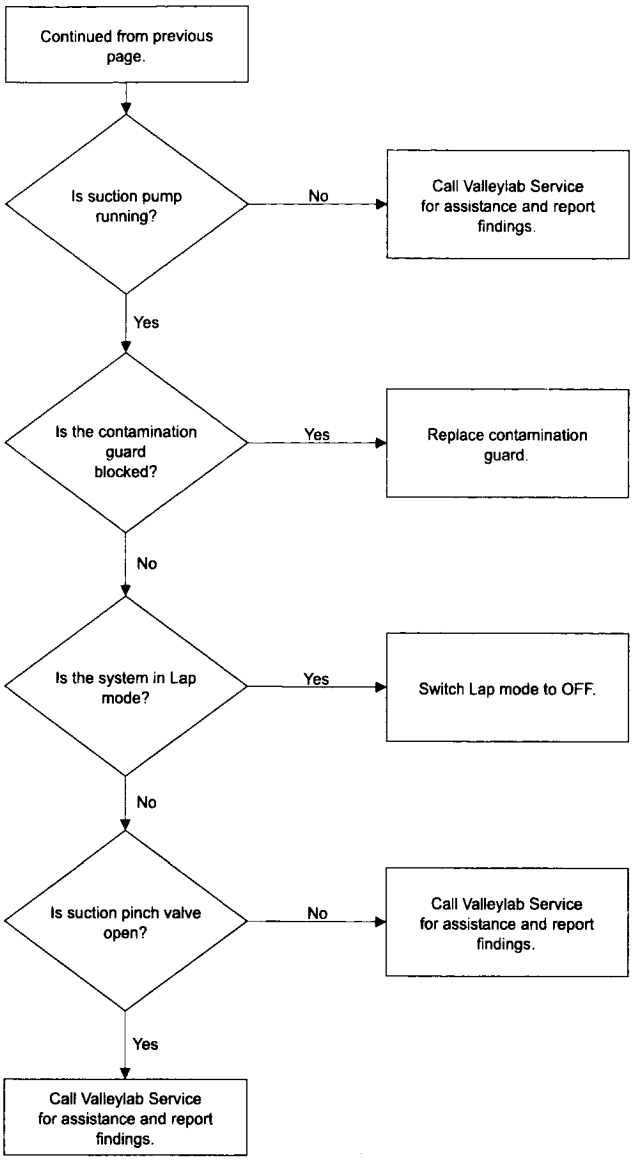

Symptom: Footswitch alarm
Is footswitch connected?
No
Connect footswitch.
Yes
Is ± 15 V supply good? (Ground = TP8, +15V = TP1, -15V = TP2 on ultrasonics board.)
No
Call Valleylab Service for assistance and report findings.
Yes
With footswitch connected, is resistance from TP8 to J9, pin 15 less than 10Ω on Ultrasonics board.
No
Measuring footswitch independently, is resistance between pins 2 and 7 less than 1Ω.
No
Call Valleylab for return aurhorization number and return footswitch.
Yes
Yes
Call Valleylab Service for assistance and report findings.

Cooling Water Alarm

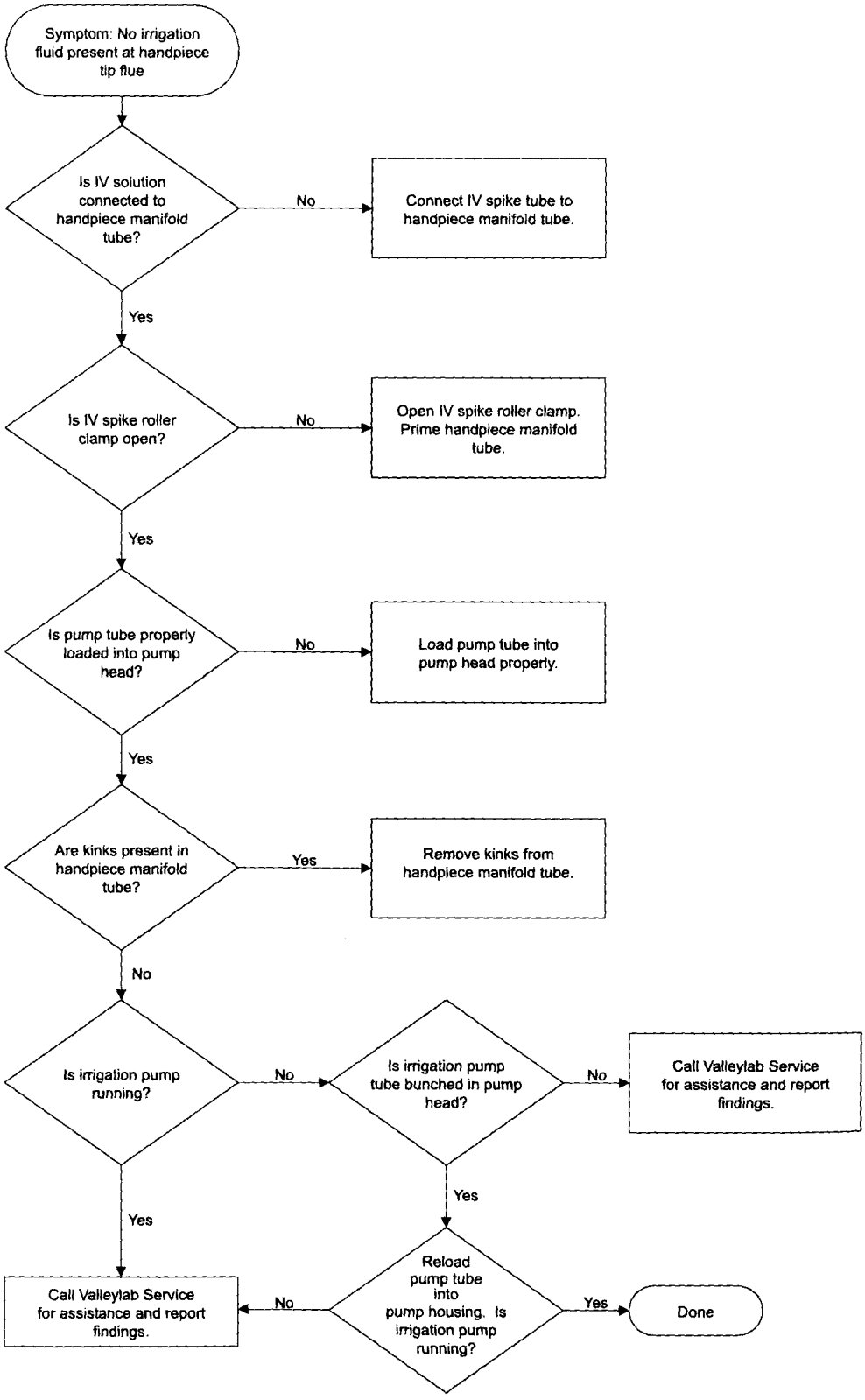

Symptom: Cooling Alarm
Is water present in reservoir?
No
Fill reservoir with distilled water. Allow approximately 30 seconds for alarm to clear.
Yes
Is reservoir fully connected into Console?
No
Remove and reinstall cooling water reservoir into Console. Allow approximately 30 seconds for alarm to clear.
Yes
Are kinks present in handpiece cable?
Yes
Remove kinks from handpiece. Allow approximately 30 seconds for alarm to clear.
No
Check cooling water reservoir sight window for water flow
Yes
Is Cooling Alarm present?
No
Done
Attach another handpiece. Cooling water alarm is removed?
Yes
Call Valleylab Service for assistance and report findings.
No
Call Valleylab Service for assistance and report findings.

Low Suction

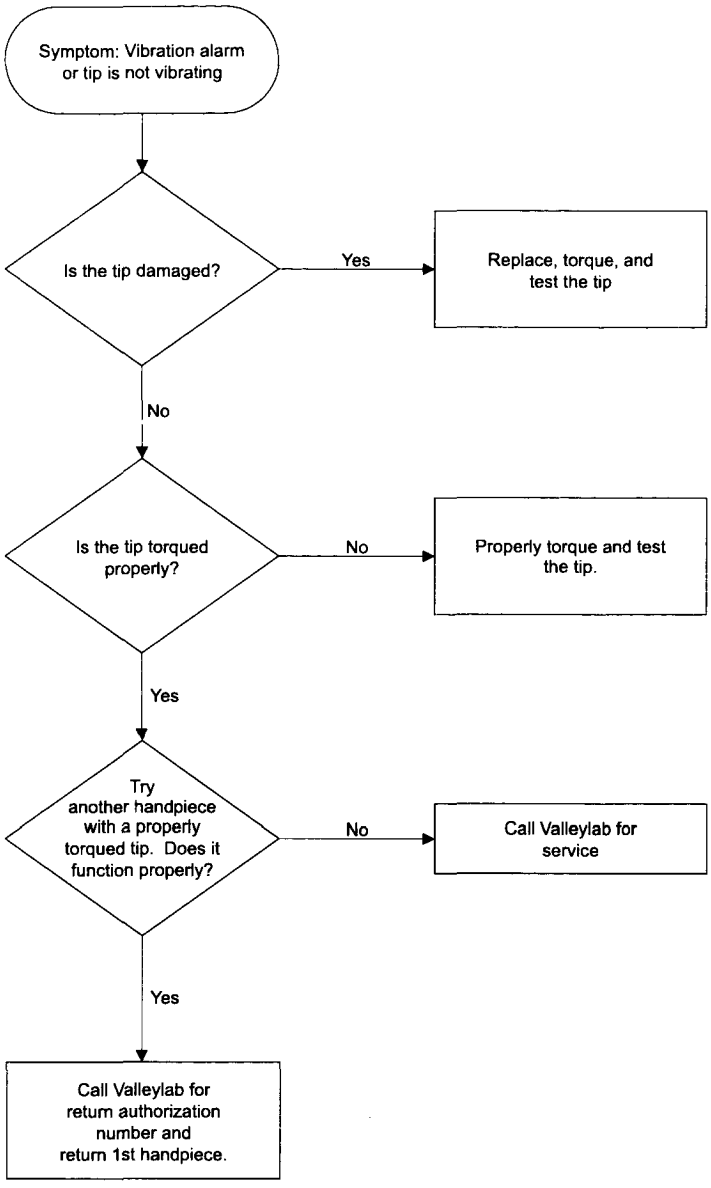

Symptom: No suction present at handpiece tip
Is handpiece tip blocked?
Yes
Remove obstruction from tip
No
Is handpiece manifold tubing kinked and/or is it properly connected?
Yes
Remove kinks from manifold tubing and re-connect tubing.
No
Is suction canister installed correctly?
No
If liner is used, is suction canister liner installed correctly?
Yes
Install suction canister correctly.
No
Install suction canister liner correctly.
Yes
Is suction canister full?
Yes
Install new suction canister
No
Is contamination guard tube kinked?
Yes
Remove kinks from contamination guard tube.
No
Continued on next page.


Continued from previous page.
Is suction pump running?
No
Call Valleylab Service for assistance and report findings.
Yes
Is the contamination guard blocked?
Yes
Replace contamination guard.
No
Is the system in Lap mode?
Yes
Switch Lap mode to OFF.
No
Is suction pinch valve open?
No
Call Valleylab Service for assistance and report findings.
Yes
Call Valleylab Service for assistance and report findings.

Low Irrigation


Symptom: No irrigation fluid present at handpiece tip flue
Is IV solution connected to handpiece manifold tube?
No
Connect IV spike tube to handpiece manifold tube.
Yes
Is IV spike roller clamp open?
No
Open IV spike roller clamp. Prime handpiece manifold tube.
Yes
Is pump tube properly loaded into pump head?
No
Load pump tube into pump head properly.
Yes
Are kinks present in handpiece manifold tube?
Yes
Remove kinks from handpiece manifold tube.
No
Is irrigation pump running?
No
Is irrigation pump tube bunched in pump head?
No
Call Valleylab Service for assistance and report findings.
Yes
Yes
Reload pump tube into pump housing. Is irrigation pump running?
Yes
Done
No
Call Valleylab Service for assistance and report findings.

Vibration Alarm


Symptom: Vibration alarm or tip is not vibrating
Is the tip damaged?
Yes
Replace, torque, and test the tip
No
Is the tip torqued properly?
No
Properly torque and test the tip.
Yes
Try another handpiece with a properly torqued tip. Does it function properly?
No
Call Valleylab for service
Yes
Call Valleylab for return authorization number and return 1st handpiece.

Replacement Procedures

In this section:

- Console covers
- Dual 24 volt power supply
- Ultrasonics and Machine Control printed circuit boards
- Control head components
- Suction control valve
- Suction pump and controller card
- Suction pinch valve
- Irrigation pump head and gear motor
- Handpiece flow sensor
- Cooling water pump tubing
- Cooling water reservoir o-rings
- Fuses.

For Your Information

For each procedure, we list the tools you need, describe how to access the part to be replaced, and describe how to install the part.

Most procedures include drawings. Where possible, the drawing appears on one side of a two-page spread, and the instructions that apply to the drawing appear on the other side of the two page spread.

Warning

Electric Shock Hazard Only trained biomedical engineers and technicians are authorized to service the CUSA EXcel system.

Electric Shock Hazard Do not touch any exposed wiring or conductive surface while the CUSA EXcel system is disassembled and energized. Never wear a grounding strap when working on an energized CUSA system.

Electric Shock Hazard Take appropriate precautions (such as the use of isolated tools and equipment; use of the "one hand rule," etc.) when taking measurements or troubleshooting the CUSA EXcel system.

High Current Hazard Do not touch the ultrasonics PCB heat sink while the CUSA EXcel system is energized. The heat sink is isolated from ground and can deliver very high current, resulting in injury.

Notice

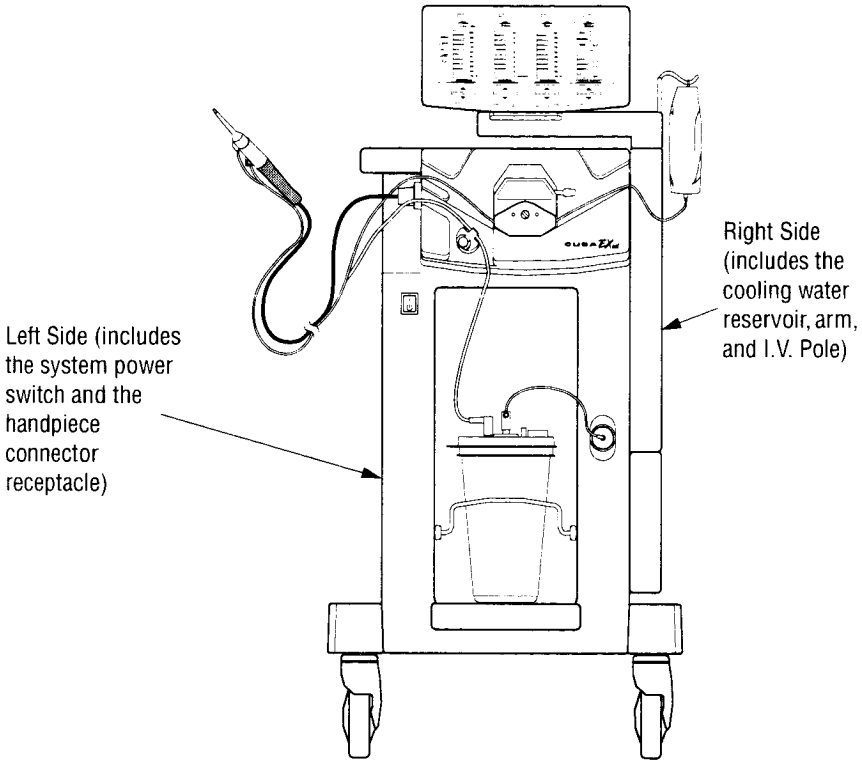
If you plan to connect the handpiece for activation, ensure that an I.V. set is available to supply cooling irrigation solution to the handpiece tip. Otherwise, damage to the tip and/or handpiece may result.

Electrostatic Sensitive Devices This unit contains electrostatic sensitive components. When repairing the system, work at a static control workstation. Wear a grounding strap when handling electrostatic sensitive components. Handle circuit boards by their nonconductive edges. Use an antistatic container for transport of electrostatic sensitive components and circuit boards.

Console Covers

You can open the left, right, or rear covers on the console to gain access to its interior. The following procedures describe how to open and re-install each cover.

Figure 11-1.
Right and left sides of the console


Left Side (includes the system power switch and the handpiece connector receptacle)
Right Side (includes the cooling water reservoir, arm, and I.V. Pole)

Tools Needed

Phillips head screwdriver

Open the Left Cover

1. Remove the left side lock screw (M5 Phillips) located under the console top near the left rear corner.
2. Push the left side latch toward the front of the console. Tilt the cover outward, then pull up to remove the cover.

Open the Right Cover

▶ ***Important***

The handpiece cooling water lines attach to the right cover. The cooling water lines include a service loop that allows you to remove the cover for servicing the system. Be careful not to remove the cover far enough to damage the lines.

1. Remove the right side lock screw (M5 Phillips) located under the console top near the right rear corner.
2. Remove the cooling water reservoir from its slot.
3. Push the right side latch toward the front of the console. Tilt the cover outward, then pull up to remove the cover.

   The cooling water lines include a service loop that allows you to remove the cover for servicing the system. Be careful not to remove the cover far enough to damage the lines.

Open the Rear Cover

1. Disconnect the footswitch connector from the receptacle on the rear panel.
2. Remove two screws (M5 Phillips) from the bottom of the rear cover.
3. Push the rear cover upwards to unhook it from the console, then remove the cover.

Re-install the Left Cover

1. Position the bottom of the cover on the left side of the console and tilted slightly outward.
2. Push the top of the cover inward toward the console. When the cover is in place, push the left side latch toward the rear of the console.
3. Replace the left side lock screw (M5 Phillips), located under the console top near the left rear corner.

Re-install the Right Cover

1. Position the bottom of the cover on the right side of the console and tilted slightly outward. Be sure that the cooling water line service loop fits into the console side.
2. Push the top of the cover inward toward the console. When the cover is in place, push the right side latch toward the rear of the console.
3. Replace the right side lock screw (M5 Phillips), located under the console top near the right rear corner.
4. Replace the cooling water reservoir.

Re-install the Rear Cover

1. Position the bottom of the cover on the rear of the console and tilted slightly outward. Allow it to slide downward and to hook into the console.
2. Hold the top of the cover against the console and replace the two screws (M5 Phillips).
3. Reconnect the footswitch connector to the receptacle on the rear panel.

Dual 24 Volt Power Supply

Replacing the dual 24 volt power supply involves removing the left side cover, disconnecting wiring harnesses, and removing the power supply chassis. Installing a new power supply reverses the process.

Tools Needed

- Phillips screwdriver
- 7 mm nut driver.

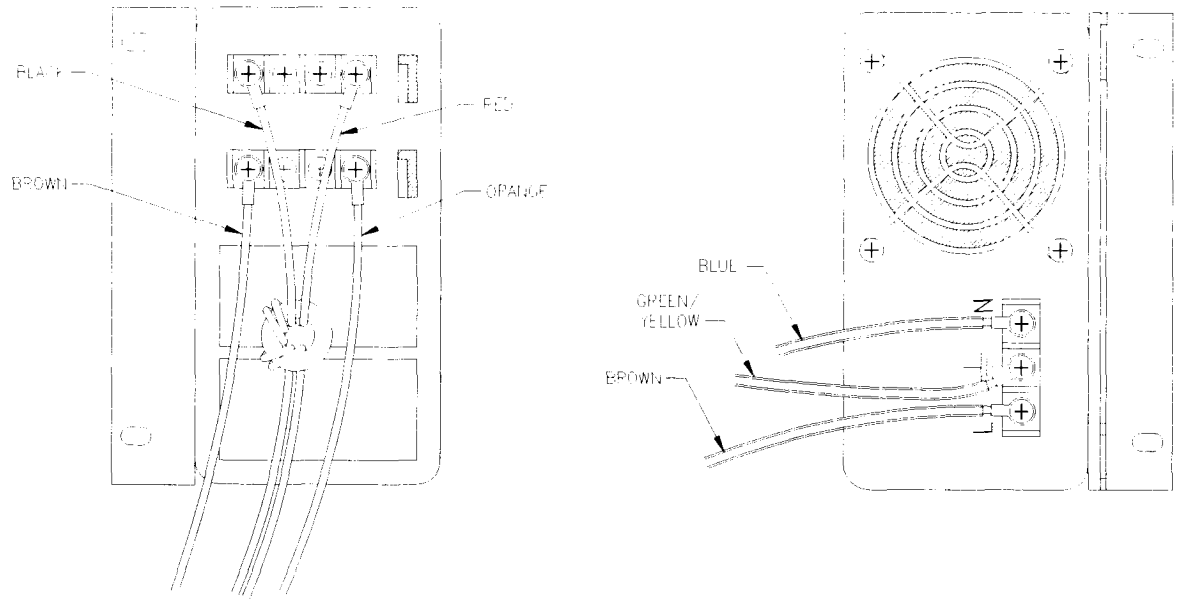
Remove the Dual 24 Volt Power Supply

1. Turn off the AC Main Switch, located on the rear panel.
2. Unplug the power cord connector from the wall receptacle.
3. Remove the left side cover.
4. Disconnect the wiring harness (refer to Figure 11-2).
5. Remove two hex nuts (M4), two lock washers, and two flat washers to release the power supply chassis from the console.
6. Slide the power supply and its chassis out the left side of the console.
7. Remove the power supply and its chassis from the console.

Install the Dual 24 Volt Power Supply

1. Replace the power supply in the console.
2. Slide the power supply and its chassis into the console.
3. Replace the two hex nuts (M4), two lock washers, and two flat washers to fasten the power supply to the console.
4. Connect the wiring harness. Refer to Figure 11-2.
5. Replace the left side cover.
6. Plug the power cord connector into a wall receptacle.
7. Turn on the AC Main Switch, located on the rear panel.

Figure 11-2.
The wiring harness on the dual 24 volt power supply



Ultrasonics and Machine Control Printed Circuit Boards

This procedure includes the steps for removing, then re-installing the ultrasonics printed circuit board (PCB) and the Machine Control PCB.

Tools Needed

You will need the following tools:

- Phillips screwdriver
- 7 mm nut driver
- ESD wrist strap.

Remove the Ultrasonics PCB

1. Turn off the AC Main Switch, located on the rear panel.
2. Unplug the power cord connector from the wall receptacle.
3. Remove the rear cover.
4. Disconnect the cable assemblies from the ultrasonics PCB. Refer to the following table and Figure 11-3.

Notice

To avoid product damage, do not remove the jumper cable or the connector at J4.

Table 11-1.
Cable connections on the ultrasonics PCB

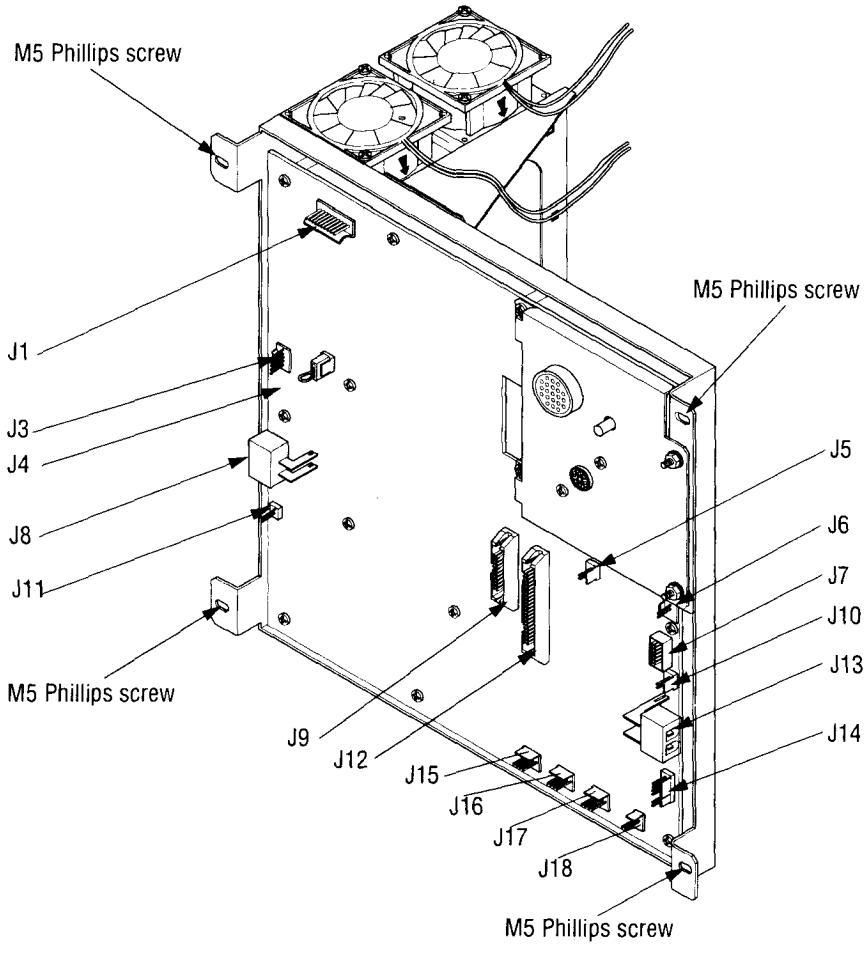
Loc.	Connector	Wire Color
J12	40-pin	ribbon cable
J9	20-pin	ribbon cable
J1	10-pin connector	yellow, brown, violet, blue, orange, red, black
J3	5-pin connector	violet, yellow
J8	large 2-pin connector	red, black
J11	small 2-pin connector	red, black
J15	4-pin connector	red, black, orange, brown
J16	4-pin connector (marked COOL)	red, black, yellow, gray
J17	4-pin connector (marked IRR)	red, black, orange, violet
J18	2-pin connector	black, black (twisted)

Loc.	Connector	Wire Color
J14	6-pin connector	red, black, red, black, red, black
J13	large 2-pin connector	orange, brown
J10	small 2-pin connector	brown, orange
J7	12-pin connector	black
J6	2-pin connector	black, black
J5	2-pin connector	green, white

5. Remove four screws (M5 Phillips) and four lock washers (M5) from the ultrasonics PCB panel. Refer to Figure 11-3.

   When you remove the ultrasonics PCB panel, you will find the heat sink and cooling fan cables attached to it.

Figure 11-3.
Cables on the ultrasonics PCB assembly

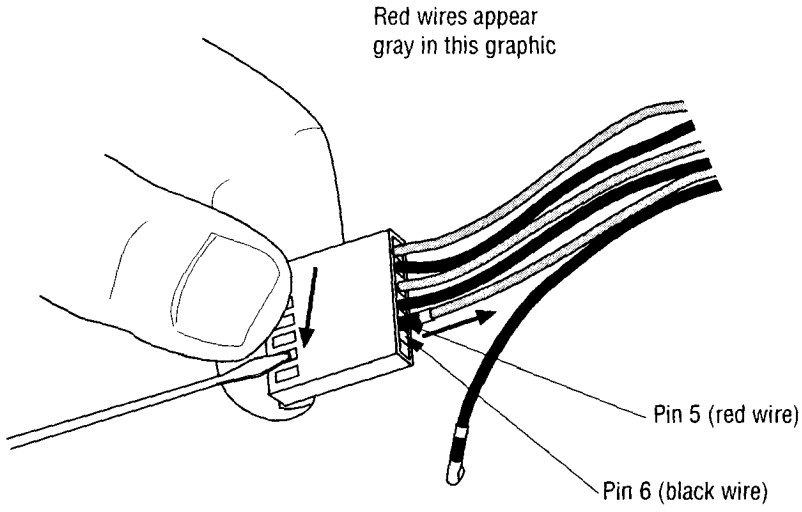


6. Remove the ultrasonics PCB assembly from the console. Place the ultrasonics PCB assembly on the floor next to the console.
7. Disconnect the ultrasonics PCB fan assembly by removing the following lead wires from the 6-pin fan connector housing (removed from J14). Refer to Figure 11-4.

Table 11-2.
Ultrasonics PCB fan assembly connectors

Color	Pin
red	5
black	6

Figure 11-4.
The ultrasonics PCB fan assembly connections



Install the Ultrasonics PCB

1. Place the new ultrasonics PCB assembly near the CUSA EXcel console. Insert the following ultrasonic PCB fan assembly lead wires into the 6-pin fan connector housing:

   Refer to Table 11-2 and Figure 11-4.

2. Position the ultrasonics PCB assembly in the CUSA EXcel console.
3. Replace four screws (M5 Phillips) and four lock washers (M5) on the ultrasonics PCB panel.
4. On the new ultrasonics PCB assembly, the header at J6 (syphon valve) has a 3.96 mm (0.156 in.) center. The CUSA EXcel console syphon valve lead wires terminate in a 2-pin connector with either a 3.96 mm (0.156 in.) or a 2.54 mm (0.100 in.) center.

   - If the connector for the console syphon valve has a 3.96 mm (0.156 in.) center, connect it to the ultrasonics PCB assembly at J6.

     OR

   - ONLY IF the connector for the console syphon valve has a 2.54 mm (0.100 in.) center, plug the syphon valve cable assembly adapter into the connector, then connect the adapter/connector assembly to the ultrasonics PCB assembly at J6. Refer to Figure 11-5.

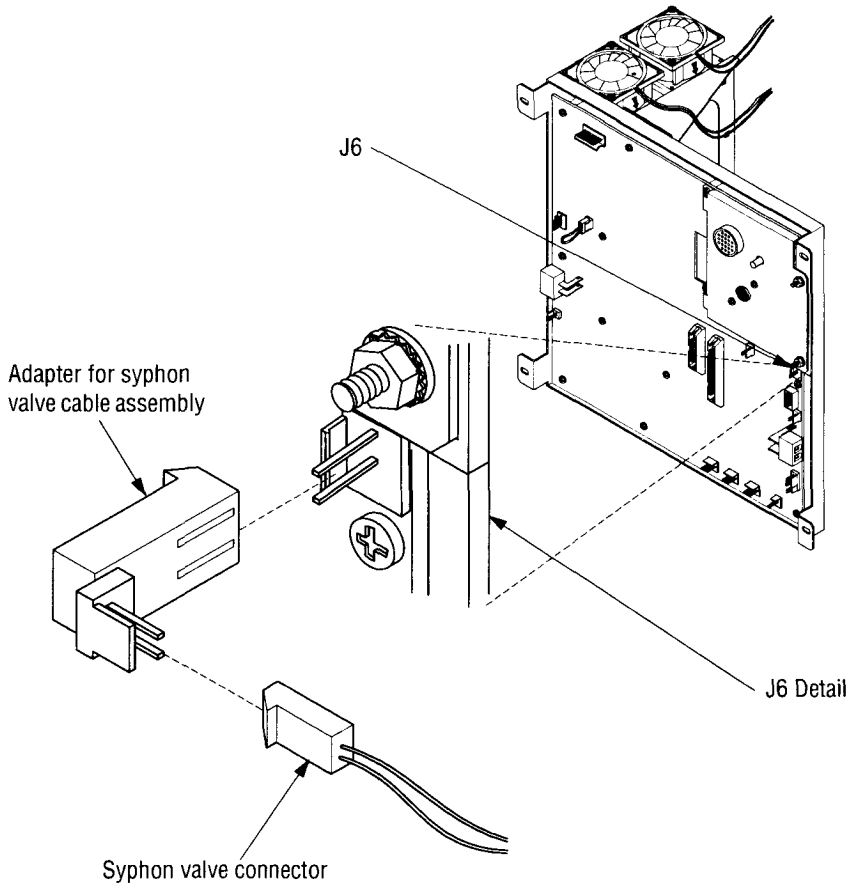


Figure 11-5.
Plugging the adapter for the syphon valve cable assembly into the connector at J6 on the ultrasonics PBC

5. Connect the cable assemblies to the ultrasonics PCB (Refer to the following table and Figure 11-3).

Table 11-3.
Cable connections on the ultrasonics PCB

Loc.	Connector	Wire Color
J5	2-pin	green, white
J7	12-pin	black
J10	small 2-pin	brown, orange
J13	large 2-pin	orange, brown
J14	6-pin	red, black, red. black, red, black
J18	2-pin	black, black (twisted)
J17	4-pin (marked IRR)	red, black, orange, violet
J16	4-pin (marked COOL)	red, black, yellow, gray
J15	4-pin	red, black, orange, brown
J11	small 2-pin	red, black
J8	large 2-pin	red, black
J3	5-pin	violet, yellow
J1	10-pin	yellow, brown, violet, blue, orange, red, black
J9	20-pin	ribbon cable
J12	40-pin	ribbon cable

6. Replace the rear cover.

Now you must replace the Machine Control PCB, which resides in the control panel assembly.

Remove the Control Panel Assembly

1. Swivel the control head so that the front of the control panel is 90° from the front of the console.
2. Remove four screws (M4 Phillips) and four lock washers (M4), located at the rear of the control head, that fasten the control panel assembly to the control head.

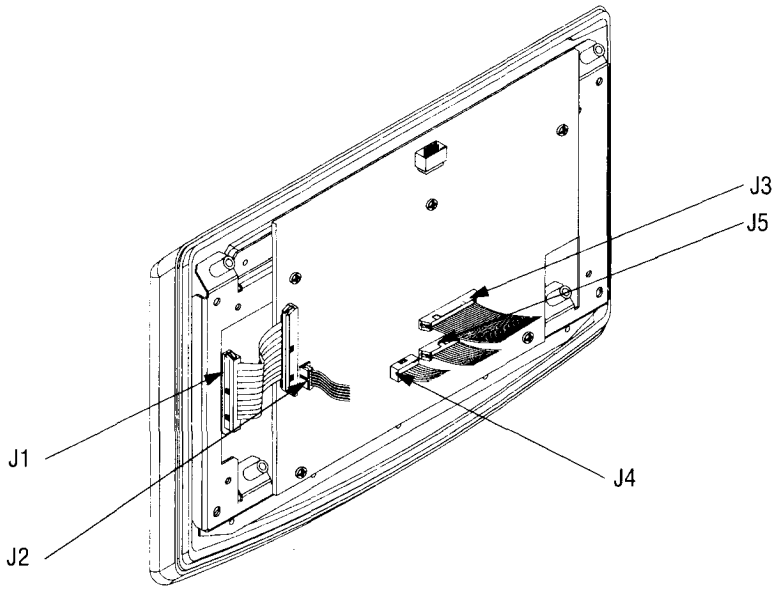
▶ ***Important***

When the screws are loose, take care not to let the control panel assembly fall out of the control head.

3. Slide the control panel forward far enough to allow disconnecting the following cables:
   - 40 pin ribbon cable (J3)
   - 20 pin ribbon cable (J5)
   - 10 pin cable (J4)
   - 6 pin cable (J2).

   Refer to Figure 11-6.

Figure 11-6.
Disconnecting control panel assembly cables



4. Remove the control panel assembly from the control head.

Remove the Machine Control PCB

Notice

Electrostatic Sensitive Devices This unit contains electrostatic sensitive components. When repairing the system, work at a static control workstation. Wear a grounding strap when handling electrostatic sensitive components. Handle circuit boards by their nonconductive edges. Use an antistatic container for transport of electrostatic sensitive components and circuit boards.

1. Attach an ESD wrist strap, then disconnect the 50-pin ribbon cable from the Machine Control PCB (J1).

   Refer to Figure 11-7.

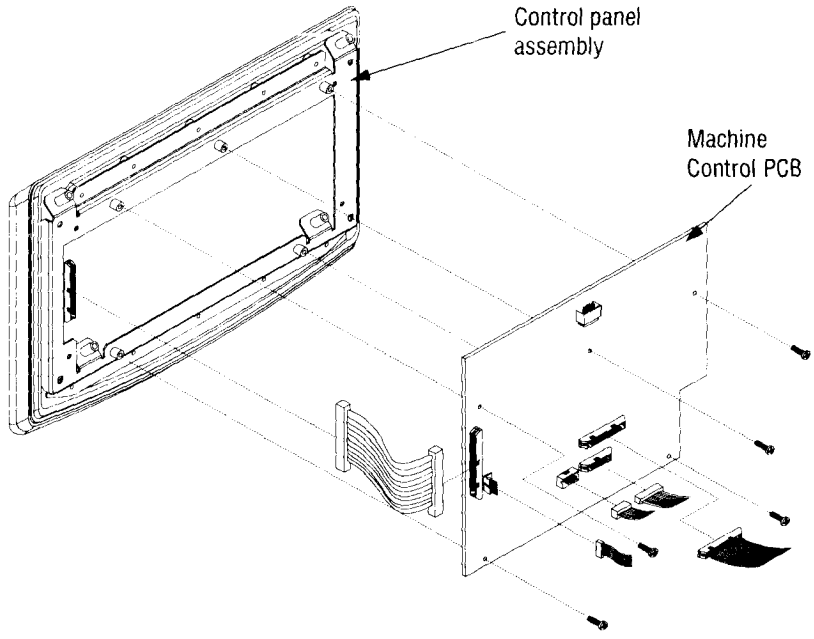


Figure 11-7.
Removing the Machine Control PCB from the control panel assembly

2. Remove five screws (M4 Phillips) from the Machine Control PCB.
3. Remove the Machine Control PCB from the control panel assembly.

Install the Machine Control PCB

1. Attach an ESD wrist strap, then remove the new Machine Control PCB from its antistatic bag.
2. Position the new Machine Control PCB in the control panel assembly. Refer to Figure 11-7.
3. Replace five screws (M4 Phillips) in the Machine Control PCB.
4. Connect the 50-pin ribbon cable to the Machine Control PCB (J1).

Install the Control Panel Assembly

1. Remove ESD strap.

Notice

To avoid product damage, remove the ESD wrist strap before connecting cables to the Machine Control PCB.

2. Position the control panel assembly at the control head opening.
3. Before sliding the control panel assembly into the control head, connect the following cables (Refer to Figure 11-6):
   - 40 pin ribbon cable (J3)
   - 20 pin ribbon cable (J5)
   - 10 pin cable (J4)
   - 6 pin cable (J2).
4. Slide the control panel assembly into the control head.
5. Replace four screws (M4 Phillips) and four lock washers (M4), located at the rear of the control head, that fasten the control panel assembly to the control head.

▶ ***Important***

While the screws are still loose, take care not to let the control panel assembly fall out of the control head.

6. Swivel the control head so that the front of the control panel aligns with the front of the console.
7. Plug the power cord connector into the wall receptacle.
8. Turn on the AC Main Switch, located on the rear panel.

Control Head Components

The control head contains three replaceable components:

- Machine control PCB
- Control panel overlay
- Display PCB.

The control panel overlay covers the front of the control panel (its fasteners are accessible inside the control head). The Machine Control PCB and display PCB (attached to a chassis) constitute two layers in a control panel assembly within the control head (refer to Figure 11-8). Gaining access to any of these components involves removing previous layer(s).

Figure 11-8.
The layers of control head components

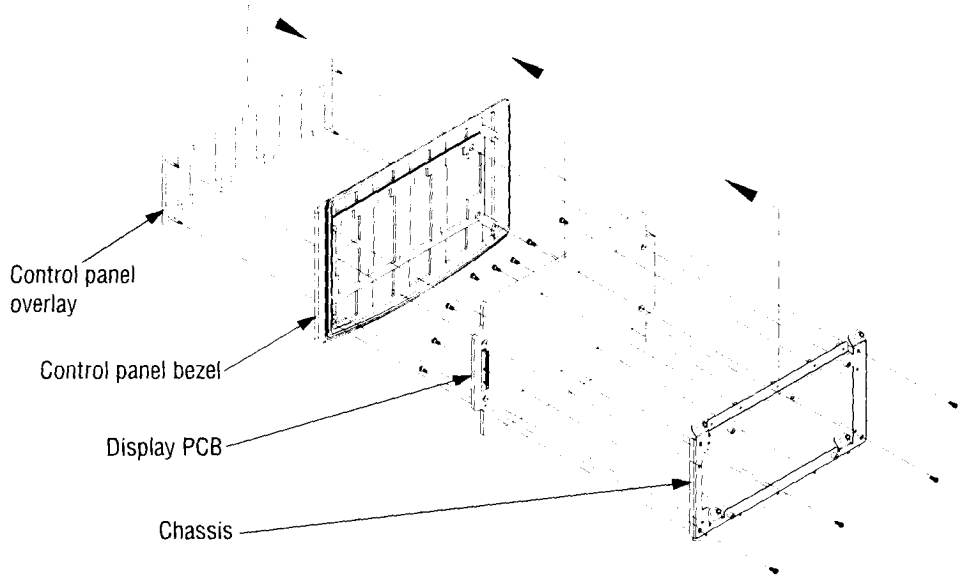


Table 11-4.
Procedures to access control panel components

To Access ...	You must ...
Control panel assembly	A: Remove it from the control head
Machine control PCB	A + B: Remove the Machine Control PCB from the control panel assembly
Control panel overlay	A + B + C: Release the overlay fasteners from the control panel assembly
Display PCB	A + B + C + D: Remove the display PCB and chassis, then separate the display PCB from its chassis

The following procedures describe how to remove and install each individual component.

Tools Needed

Phillips head screwdriver

Remove the Control Panel Assembly

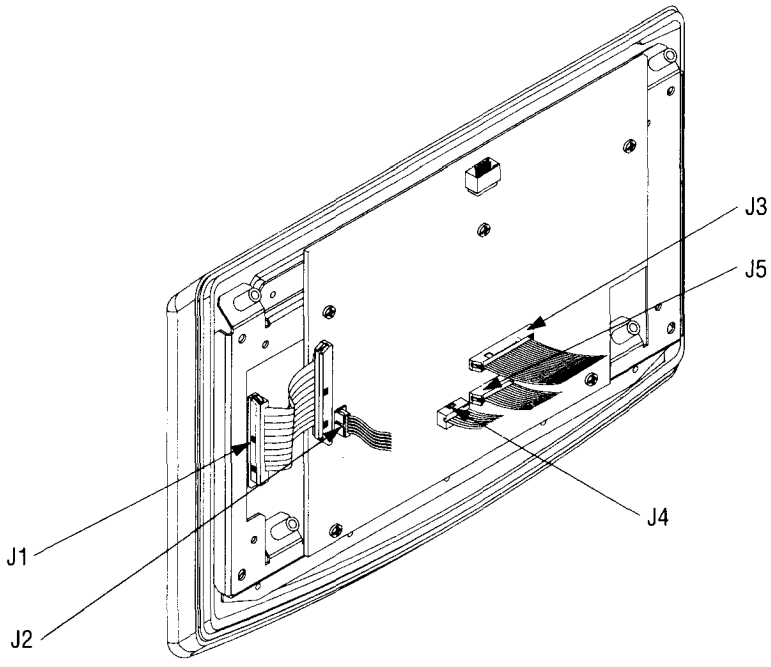
1. Turn off the AC Main Switch, located on the rear panel.
2. Unplug the power cord connector from the wall receptacle.
3. Swivel the control head so that the front of the control panel is 90° from the front of the console.
4. Remove four screws and four lock washers (M4 Phillips), located at the rear of the control head, that fasten the control panel assembly to the control head.

▶ ***Important***

When the screws are loose, take care not to let the control panel assembly fall out of the control head.

5. Slide the control panel forward far enough to allow disconnecting the following cables (refer to Figure 11-9):
   - 40 pin ribbon cable (J3)
   - 20 pin ribbon cable (J5)
   - 10 pin cable (J4)
   - 6 pin cable (J2).
6. Remove the control panel assembly from the control head.

Figure 11-9.
Disconnecting control panel cables



Remove the Machine Control PCB

Notice

Electrostatic Sensitive Devices This unit contains electrostatic sensitive components. When repairing the system, work at a static control workstation. Wear a grounding strap when handling electrostatic sensitive components. Handle circuit boards by their nonconductive edges. Use an antistatic container for transport of electrostatic sensitive components and circuit boards.

1. Attach an ESD wrist strap, then disconnect the 50-pin ribbon cable from the Machine Control PCB (J1). Refer to Figure 11-9.
2. Remove five screws (M4 Phillips) from the Machine Control PCB.
3. Remove the Machine Control PCB from the control panel assembly.

Remove the Control Panel Overlay

Four snap-in standoffs fasten the overlay to the control panel assembly.

1. To gain access to the standoffs within the control panel assembly, remove the Machine Control PCB.
2. With your fingertips, squeeze the spring-loaded flanges on the standoffs to retract them.
3. With the flanges retracted, push the standoffs out of the control panel assembly to release the overlay.

Remove the Display PCB

1. Remove the control panel overlay.
2. Remove four screws and four lock washers (M4 Phillips) from the display PCB chassis.
3. Tilt the display PCB and chassis backward at the top. Lift the display PCB and chassis from the control panel bezel, being careful to make sure the silicon buttons clear the bezel.
4. Remove the display PCB from the chassis (refer to Figure 11-11):
   a. Remove eight screws (M4 Phillips) from the display PCB.
   b. Lift the display PCB from the chassis.

Figure 11-10.
Disconnecting the 50-pin ribbon cable and removing the Machine Control PCB

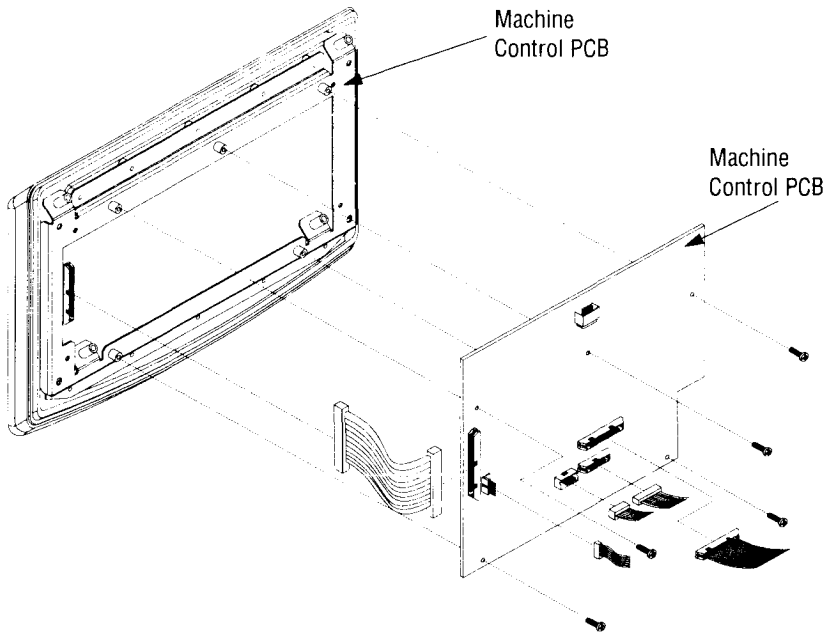
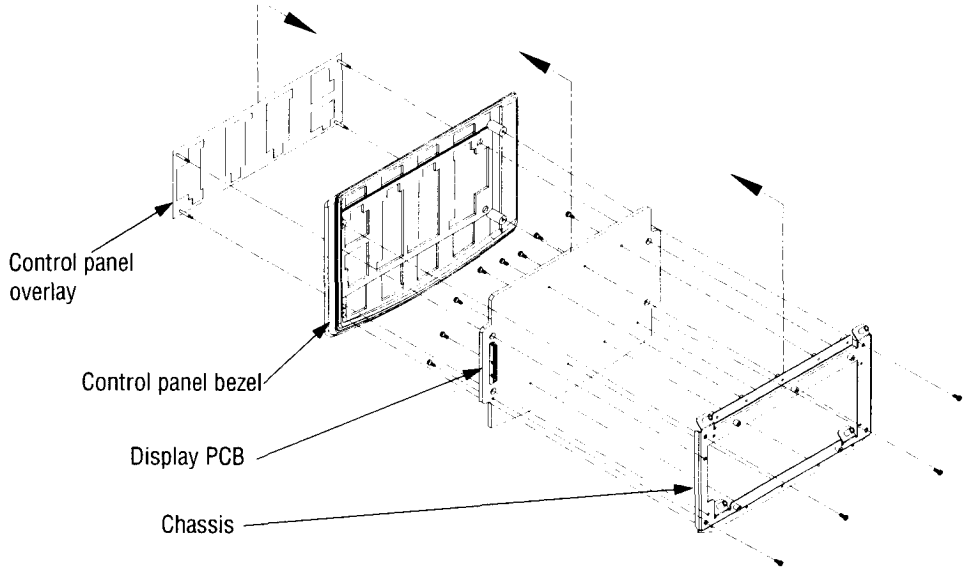


Figure 11-11.
Removing the Display PCB from the control head assembly



Install the Display PCB

1. Attach the display PCB to its chassis:
   a. Position the display PCB onto the chassis.
   b. Replace the eight screws (M4 Phillips) in the display PCB.
2. Being careful to make sure the silicon buttons clear the bezel, position the display PCB and chassis in the control panel bezel.

3. Replace the four screws and four lock washers (M4 Phillips) on the display PCB chassis.
4. Replace the control panel overlay.

Install the Control Panel Overlay

1. Identify the overlay to be used.
2. Position it correctly on the control panel assembly.
3. When the tips of the standoffs rest in the corresponding holes in the control panel assembly, push on the standoffs with your thumbs until you feel and hear them snap into place.

   Note: Use an adhesive sealant at the top of the control panel overlay.

Install the Machine Control PCB

1. Position the Machine Control PCB in the control panel assembly.
2. Replace five screws (M4 Phillips) in the Machine Control PCB.
3. Connect the 50-pin ribbon cable to the Machine Control PCB (J1).

Install the Control Panel Assembly

1. Remove ESD strap.

Notice

To avoid product damage, remove the ESD wrist strap before connecting cables to the Machine Control PCB.

2. Position the control panel assembly at the control head opening.
3. Before sliding the control panel assembly into the control head, connect the following cables:

- 40 pin ribbon cable (J3)
- 20 pin ribbon cable (J5)
- 10 pin cable (J4)
- 6 pin cable (J2).

4. Slide the control panel assembly into the control head.
5. Replace four screws and four lock washers (M4 Phillips), located at the rear of the control head, that fasten the control panel assembly to the control head.

▶ ***Important***

While the screws are still loose, take care not to let the control panel assembly fall out of the control head.

6. Swivel the control head so that the front of the control panel aligns with the front of the console.
7. Plug the power cord connector into the wall receptacle.
8. Turn on the AC Main Switch, located on the rear panel.

Suction Control Valve

The following procedure describes how to remove, then re-install, the suction control valve.

Tools Needed

You will need the following tools:

- Phillips screwdriver
- Metric socket/driver set
- Metric Allen hex key wrench set
- Metric wrench set
- Pliers
- Razor blade knife
- Plastic wire ties.

Remove the Suction Control Valve

Access the Suction Control Valve

1. Turn off the AC Main Switch, located on the rear panel.
2. Unplug the power cord connector from the wall receptacle.
3. Remove the left, right, and rear covers.
4. Disconnect the suction control valve from the ultrasonics PCB (J7).
5. Lift the arm and control head to the highest position.

6. Remove the left end of the suction pump chamber by removing four screws (M4 Phillips) and four lock washers (M4). Refer to Figure 11-12.
7. Remove the right end of the suction pump chamber by removing four screws (M4 Phillips) and four lock washers (M4). Refer to Figure 11-12.
8. Remove the suction pump enclosure. Refer to Figure 11-13.

   Note: The suction pump enclosure, an L-shaped part, attaches to a baffle suction pump enclosure. Do not disassemble the two parts.

   a. Remove four screws (M4 Phillips) and four lock washers (M4)—two of each on either end of the enclosure.
   b. Slightly lean the enclosure toward the rear of the console so that, as you remove it, the enclosure will clear other components in the console.
   c. Carefully pull the suction pump enclosure out the left side of the console.

Figure 11-12.
Removing the ends from the suction pump chamber

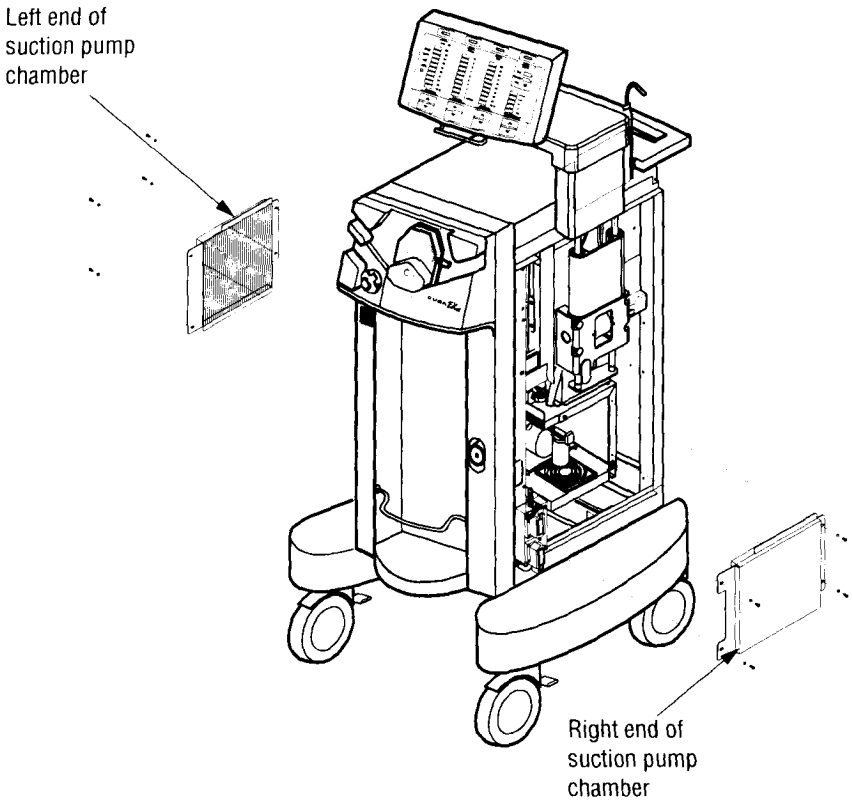
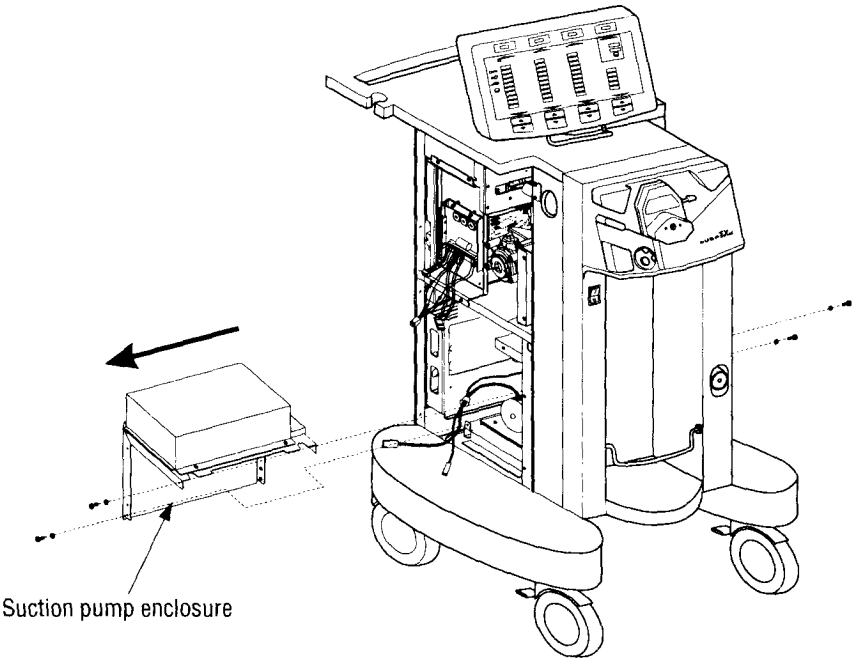


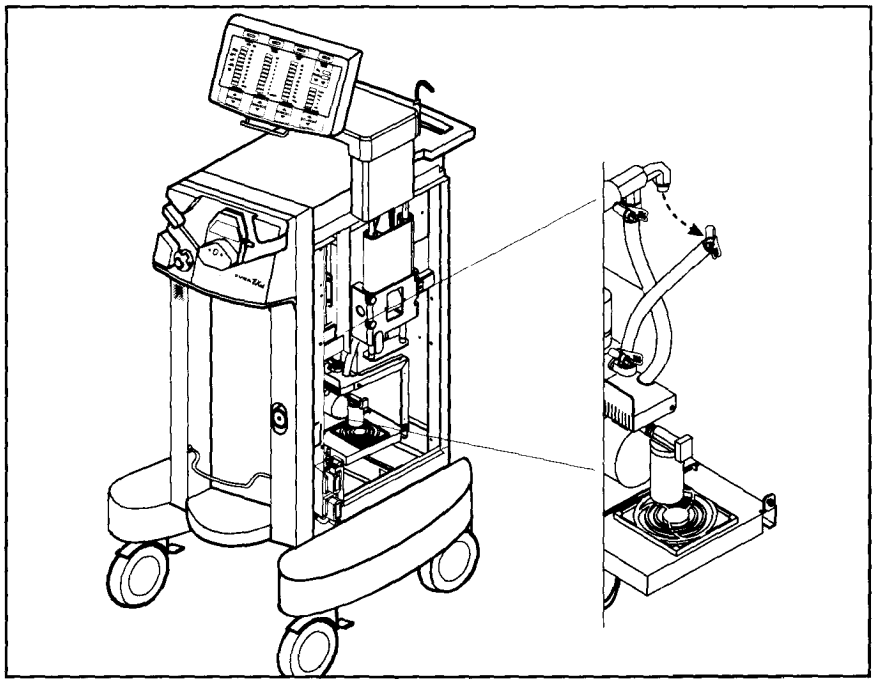
Figure 11-13.
Removing the suction pump enclosure from the console



Disconnect, Lift Out, and Disassemble the Control Valve Assembly

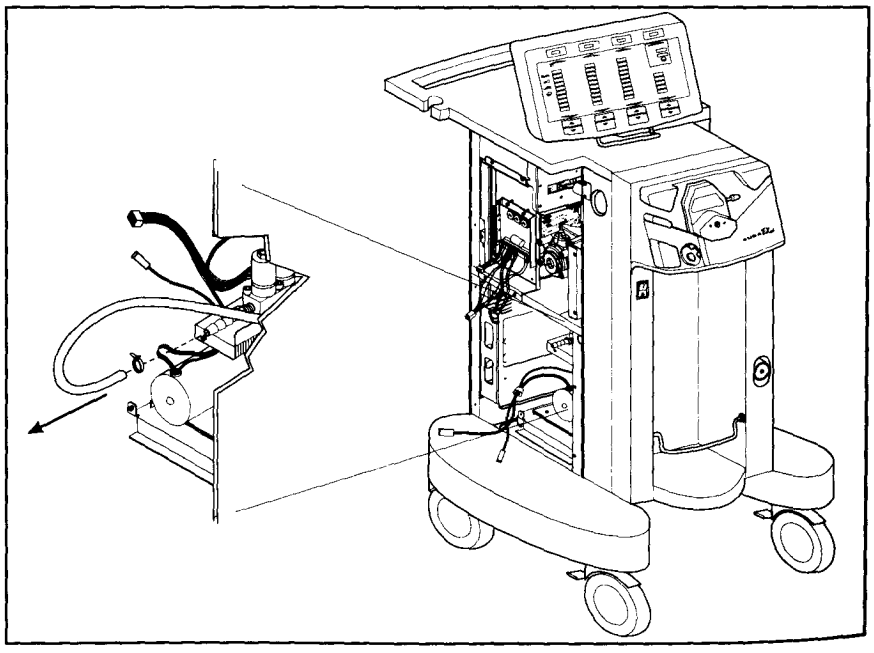
1. Disconnect the 3/8 in. inner diameter (ID) suction tube and clamp at the contamination guard 90° elbow located above the right end of the suction control valve.

Figure 11-14.
Disconnecting the suction tube at the contamination guard 90° elbow



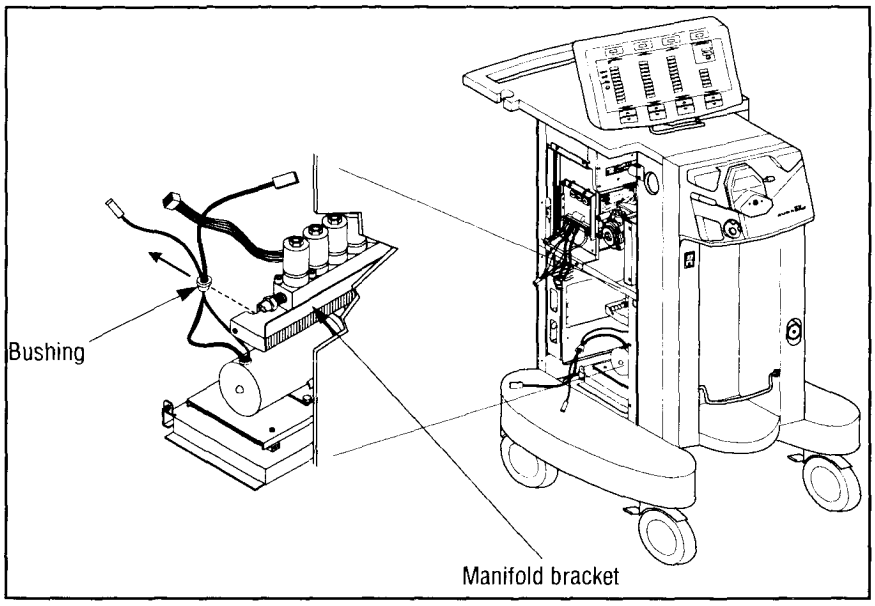
2. Remove the cable tie and disconnect the 1/8 in. ID tube that connects to the left end of the control valve.

Figure 11-15.
Disconnecting the suction tube from the left end of the suction control valve



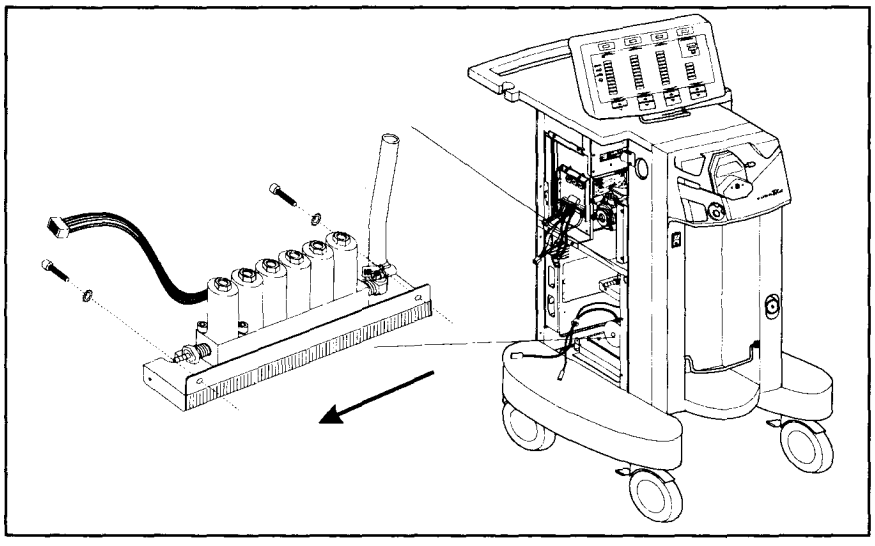
3. Pull the strain relief bushing for suction pump motor wires away from the manifold bracket (a mounting bracket for the suction control valve).

Figure 11-16.
Pulling the strain relief bushing away from the manifold bracket



4. Remove the manifold bracket from the console:
   a. Remove two hex bolts (M5) and two lock washers that secure the manifold bracket to the frame.
   b. Carefully lift the manifold bracket (and suction control valve) out the left side of the console.

Figure 11-17.
Removing the manifold bracket from the console



5. Remove the suction control valve from the manifold bracket:

   a. Remove three screws (M4 socket head cap screws) from the suction control valve.

      Note: A lock washer secures the screw on each end of the assembly, but no lock washer secures the third screw.

   b. Lift the suction control valve from the manifold bracket.

      Note: The inlet screen for the suction control valve becomes unattached when you lift the suction control valve off the manifold bracket.

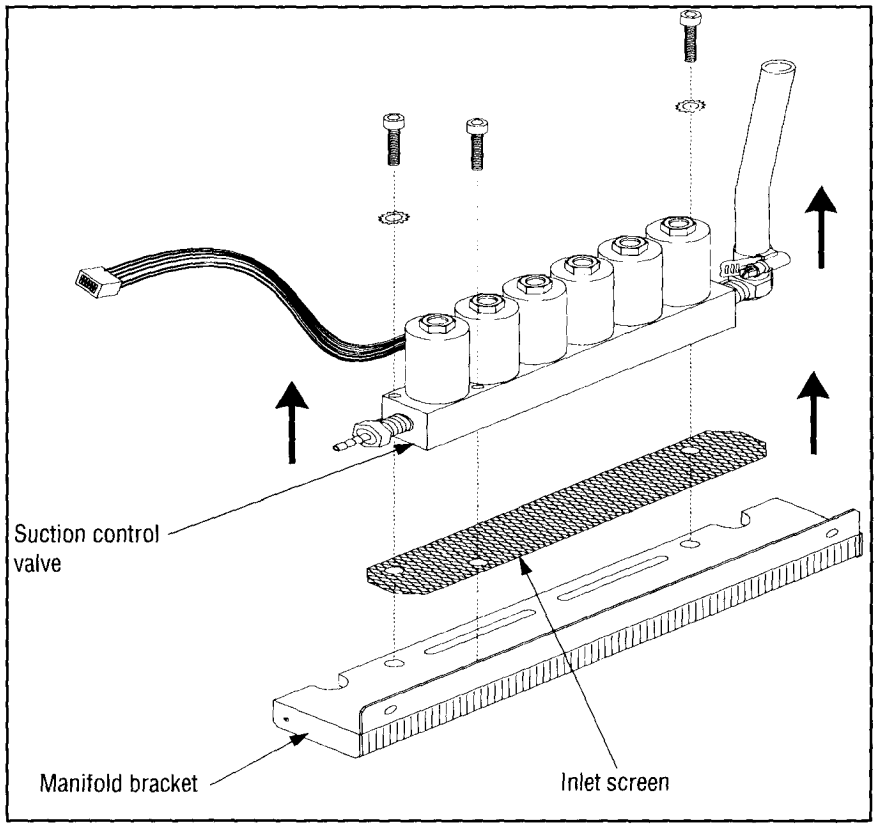
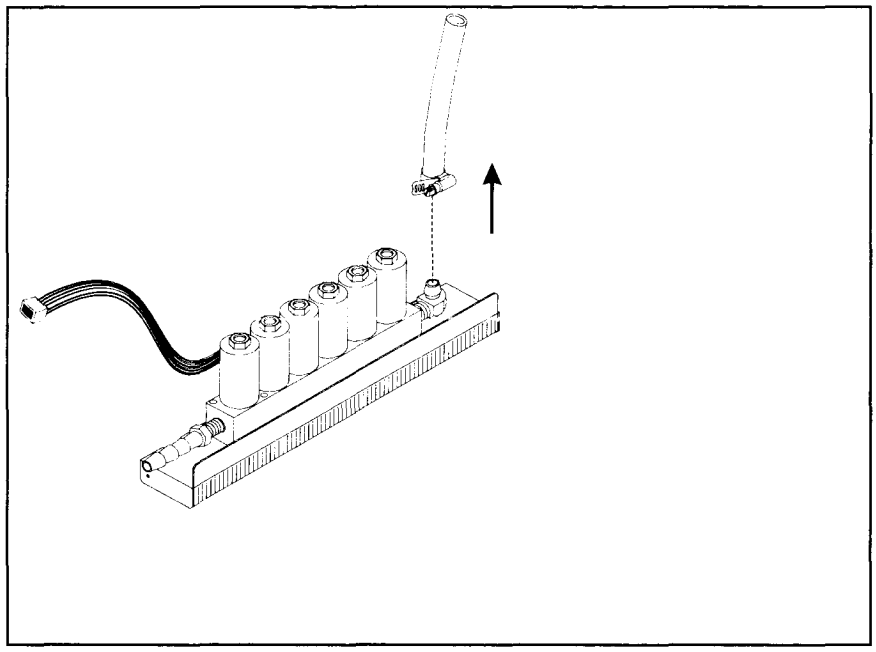


Figure 11-18.
Removing the suction control valve from the manifold bracket

6. Remove 3/8 in. ID suction tube and clamp from the suction control valve: Set them aside for re-use.

   Note: The new suction control valve does not include this tube and clamp.

Figure 11-19.
Removing the suction hose and clamp from the suction control valve



Install the Suction Control Valve

Assemble the Suction Control Valve to the Manifold Bracket

1. Attach the 3/8 in. ID suction tube and clamp to the suction control valve.
2. Attach the suction control valve to the manifold bracket:
   a. Position the suction control valve inlet screen on the manifold bracket so that its three holes align with the three screw holes in the bracket.
   b. Position the suction control valve on the manifold bracket so that its three holes align with the three screw holes in the inlet screen and bracket.
   c. Replace three screws (M4 socket head cap screws) in the suction control valve.

      Note: A lock washer secures the screw on each end of the assembly, but no lock washer secures the third screw.

Install the Suction Control Valve in the Console

1. Install the manifold bracket in the console:
   a. Position the manifold bracket in the console.
   b. Replace two hex bolts (M5) and two lock washers, securing the manifold bracket to the frame.
2. Secure the strain relief bushing for suction pump motor wires in the manifold bracket.
3. Connect the 1/8-in. ID tube to the left end of the control valve and secure the tube with one cable tie.
4. Connect the 3/8 in. suction tube and clamp to the contamination guard 90° elbow located above the right end of the suction control valve.

Install the Suction Pump Enclosure and Close the Suction Chamber

1. Replace the suction pump enclosure:
   a. Carefully insert the enclosure into the left side of the console.
   b. Slightly lean the enclosure toward the back of the console so that, as you slide the enclosure into the console, the enclosure will clear other components.
   c. Replace two screws (M4 Phillips) and two lock washers (M4) on each end of the enclosure.
2. Replace the right end of the suction pump chamber by replacing four screws (M4 Phillips) and four lock washers (M4).
3. Replace the left end of the suction pump chamber by replacing four screws (M4 Phillips) and four lock washers (M4).
4. Return the arm and control head to normal position.
5. Connect the suction control valve to the ultrasonics PCB (J7).
6. Replace the left, right, and rear covers.
7. Plug the power cord connector into the wall receptacle.
8. Turn on the AC Main Switch, located on the rear panel.

Suction Pump and Controller Card

The suction pump and the suction pump controller card are a set; replacing one *requires* replacing the other. This procedure describes how to access and remove the suction pump, install a new suction pump, remove the suction pump controller card, and install a new suction pump controller card.

Remove the Suction Pump

1. Turn off the AC Main Switch, located on the rear panel.
2. Unplug the power cord connector from the wall receptacle.
3. Remove the left, right, and rear covers.
4. Lift the arm and control head to the highest position.
5. Remove the left end of the suction pump chamber by removing four screws (M4 Phillips) and four lock washers (M4).
6. Remove the right end of the suction pump chamber by removing four screws (M4 Phillips) and four lock washers (M4).
7. Remove the suction pump enclosure:

   Note: The suction pump enclosure, an L-shaped part, attaches to a baffle suction pump enclosure. Do not disassemble the two parts.

   a. Remove four screws (M4 Phillips) and four lock washers (M4)—two of each on either end of the enclosure.
   b. Slightly lean the enclosure toward the rear of the console so that, as you remove it, the enclosure will clear other components in the console.
   c. Carefully pull the suction pump enclosure out the left side of the console.

Disconnect and Remove the Suction Pump

1. Remove the 3/8 in. ID suction tube and clamp from the "T" fitting at the back of the contamination guard.

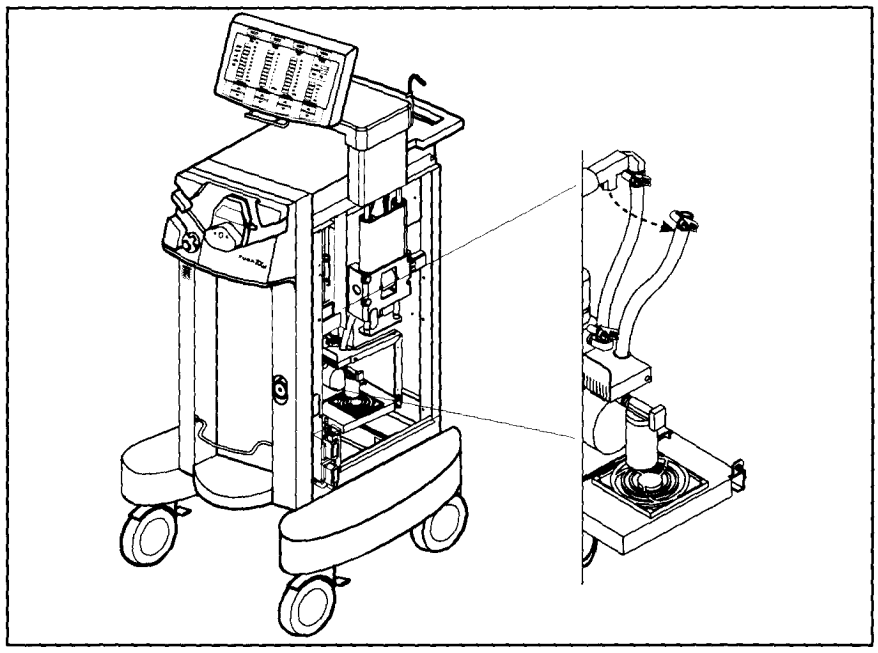


Figure 11-20.
Removing the suction tube and clamp from the "T" fitting

2. Pull the split bushing restraint on the suction tube away from the manifold bracket (near the right end of the bracket).

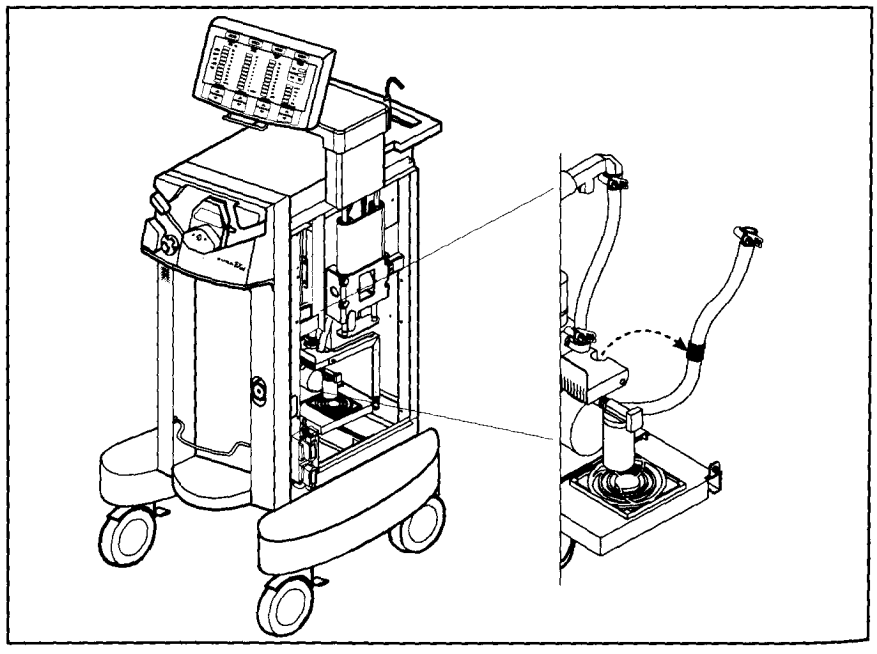


Figure 11-21.
Pulling the split bushing away from the manifold bracket

3. Disconnect the cables from the suction pump to the suction pump controller card:

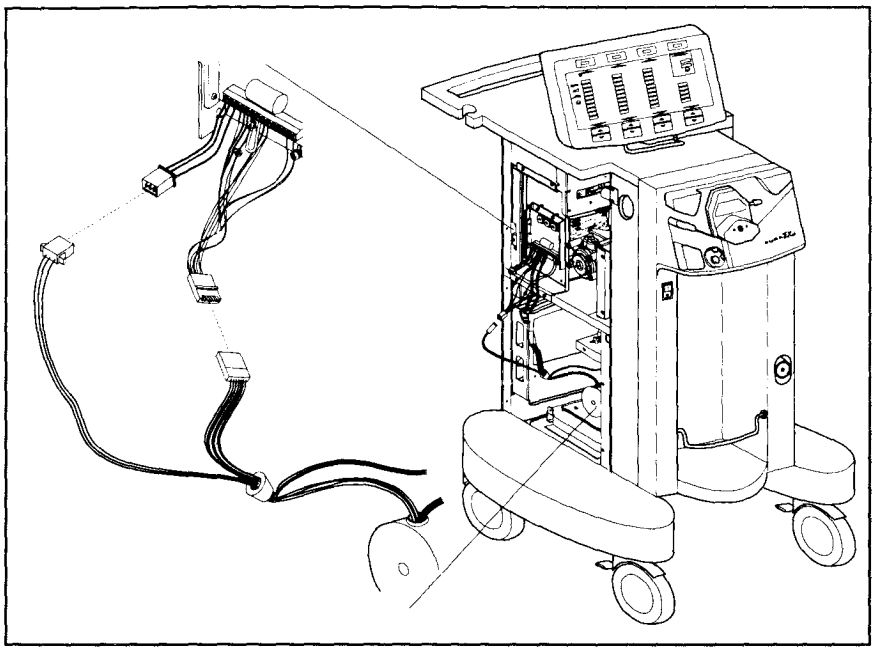


Figure 11-22.
Disconnecting cables from the suction pump to the suction pump controller card

Table 11-5.
Suction pump cable connections to the controller card

Connector	Wire Color
3-pin, white	red, blue, yellow
7-pin, black	yellow, brown, green, red, orange*

* *The jumper wire occupies pins 6 and 7 on the connector.*

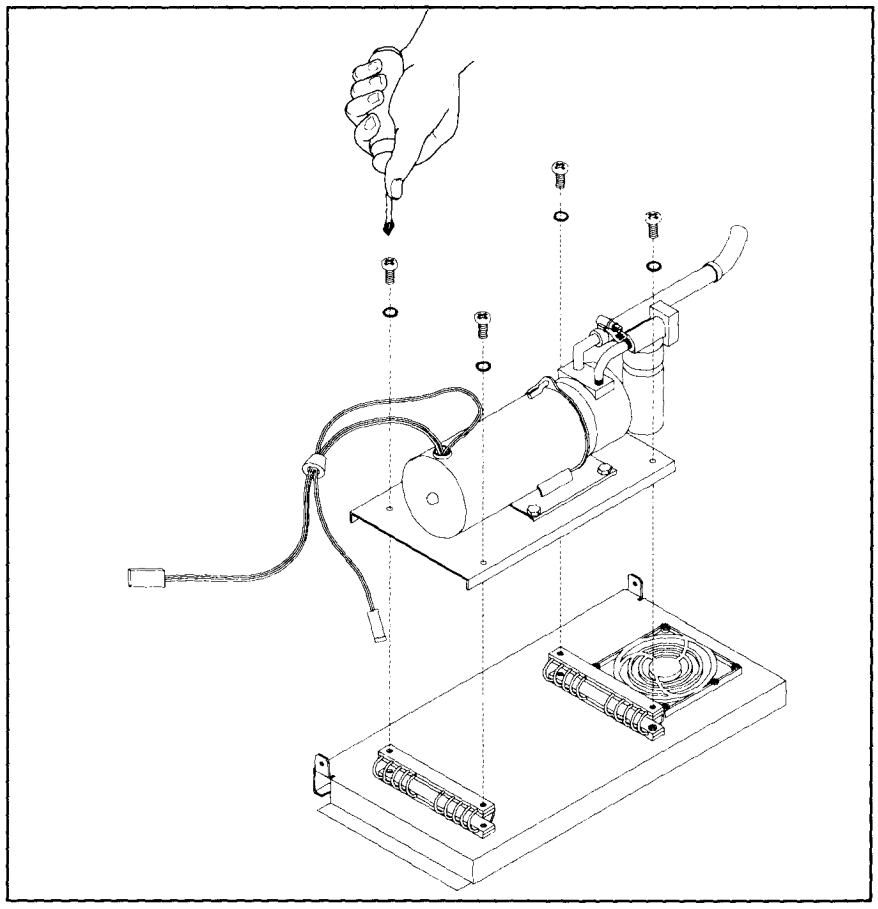
4. Pull the strain relief bushing for suction pump motor wires away from the manifold bracket.

5. Remove the suction pump and its bracket mount from the wire rope isolators:

   a. Remove four screws (M5 Phillips) and four lock washers (M5).

      You need a *short* Phillips screwdriver for this task.

   b. Carefully lift the suction pump and its bracket mount from the wire rope isolators.

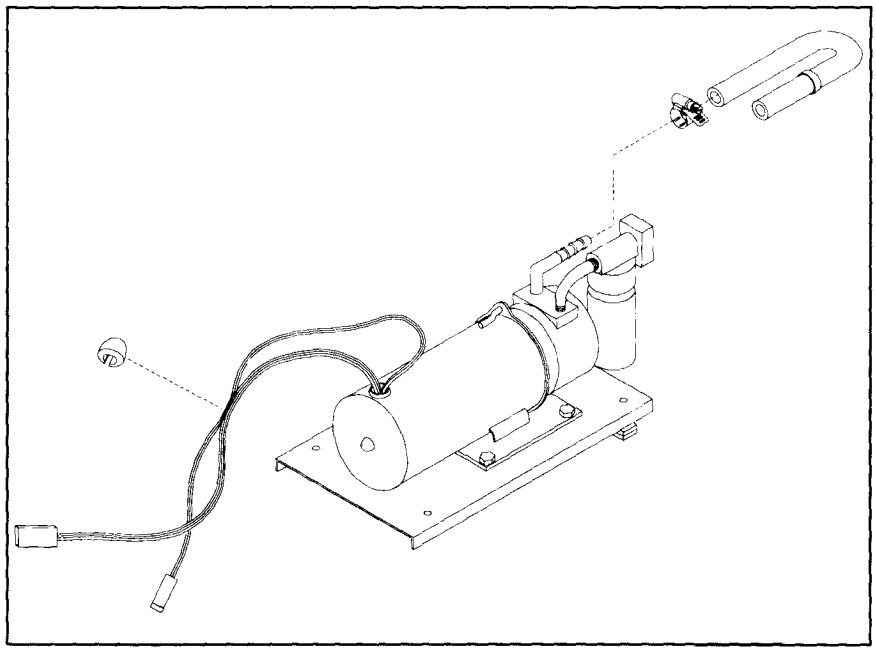


6. Remove the 3/8 in. ID suction tube and clamp from the 90° elbow on the suction pump: Set them aside for re-use.

   Note: Do not remove the split bushing restraint from the tube.

   Note: The new suction pump does not include this tube, clamp, or bushing.

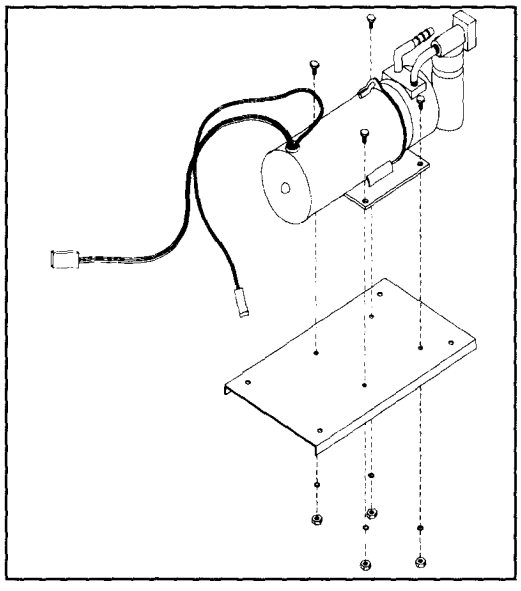
Figure 11-23.
Removing the suction tube and strain relief bushing from the suction pump and its wires



7. Remove the strain relief bushing from the suction pump wires: Set it aside for re-use. Refer to Figure 11-23.

Figure 11-24.
Removing the suction pump from its bracket mount

8. Remove the suction pump from the suction pump bracket mount:
   a. Remove four bolts (M6), four lock washers (M6), and four nuts (M6).
   b. Lift the pump off the bracket mount.



Install the Suction Pump

Prepare the New Pump for Installation

1. Open the packaging for the new suction pump. You will find the pump pre-connected to a pump controller card. A printed label covers the white 3-pin connector.
   a. Cut, but do not remove, the label on the white 3-pin connector.
   b. Unplug the connectors.
   c. Remove the new suction pump.
2. Attach the suction pump to the suction pump bracket mount:
   a. Position the pump so that it *centers* on the bracket mount; no part of the pump body should extend over any edge of the bracket.
   b. Replace four bolts (M6), four lock washers (M6), and four nuts (M6).

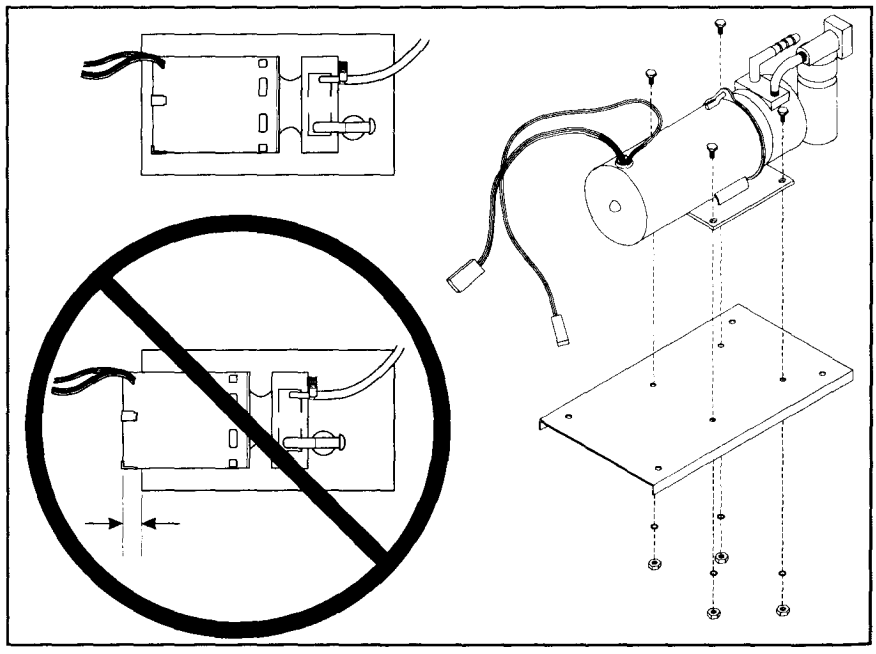


Figure 11-25.
Attaching the suction pump motor to its mounting bracket, making sure to center the pump on the bracket

3. Install attachments:
   a. Remove the red plastic cap from the 90° elbow at the pump inlet.
   b. Connect the 3/8 in. ID suction tube and clamp to the 90° elbow on the suction pump inlet.

      Note: The split bushing restraint should still be on the tube.
4. Position the strain relief bushing on the suction pump wires 20 cm (8 in.) from where the wires exit the pump. Crimp the strain relief bushing in place with pliers.

Install the Pump in the Console

1. Install the suction pump and its bracket mount onto the wire rope isolators:
   a. Carefully position the suction pump and its bracket mount on the wire rope isolators.
   b. Replace four screws (M5 Phillips) and four lock washers (M5).

      Tip: You need a *short* Phillips screwdriver for this task.
2. Connect the 3/8 in. suction tube and clamp from the pump to the "T" fitting at the back of the contamination guard.
3. Push the split bushing restraint on the suction tube into the manifold bracket (near the right end of the bracket).
4. Push the strain relief bushing for suction pump motor wires into the manifold bracket.
5. Install the suction pump enclosure:
   a. Carefully insert the suction pump enclosure into the left side of the console.

      Tip: When you replace the screws, replace the top screws (enclosure-to-manifold bracket) first.
   b. Replace four screws (M4 Phillips) and four lock washers (M4)—two on each end of the enclosure.
6. Attach the right end of the suction pump chamber; use four screws (M4 Phillips) and four lock washers (M4).
7. Attach the left end of the suction pump chamber; use four screws (M4 Phillips) and four lock washers (M4).

Ready for Suction Pump Controller Card Replacement

At this point, you have removed the suction pump, then re-installed several components:

- New suction pump
- Suction pump enclosure
- Suction chamber end panels.

The new suction pump is not yet connected to the controller card. The reason is simple: If you replace the suction pump, you *must* replace the controller card. Likewise, if you replace a controller card, you *must* replace the suction pump.

Remove the Suction Pump Controller Card

1. Disconnect the controller card from the ultrasonics board at J15:

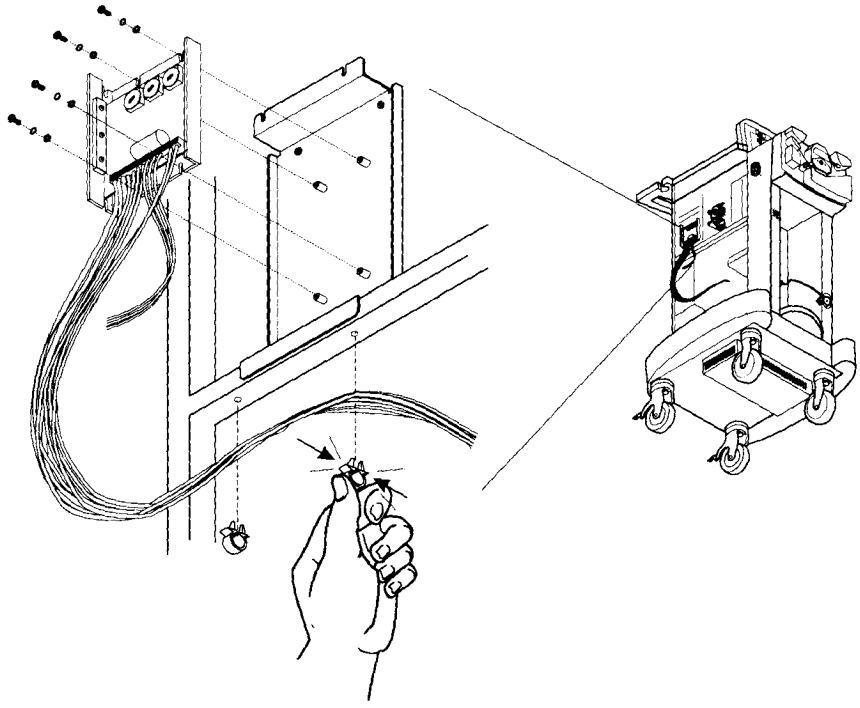
Table 11-6.
The suction pump controller card cable to the ultrasonics PCB

Connector	Wire Color
4-pin	red, black, orange, brown

▶ ***Important***
The cables in the cable clamps sometimes tangle. When you pull the controller card cable away from the console, be careful to avoid pulling other cables with it.

2. Remove the two cable clamps on the bottom of the controller card bracket, then separate the controller card cable from other cables in the clamps.
3. Remove the suction pump controller card from the motor control bracket by removing four screws (M4 Phillips), four lock washers (M4), and four flat washers (M4).

Figure 11-26.
Removing the cable clamps and screws from the suction pump controller card



Install the Suction Pump Controller Card

Notice

To avoid product damage, when handling the suction pump controller card, do not turn the three white adjustment dials designated as current limit (R13), max speed (R12), and min speed (R11).

1. Attach the new suction pump controller card to the motor control bracket using four screws (M4 Phillips), four lock washers (M4), and four flat washers (M4).
2. Replace the two cable clamps on the bottom of the controller card bracket.
3. Connect the controller card cables:

Table 11-7.
Suction pump cable connections

Loc	Connector	Wire Color
J15 (ultrasonics PCB)	4-pin	red, black, orange, brown
Cable from suction pump	7-pin, black	yellow, brown, green, red, orange*
Cable from suction pump	3-pin, white	red, blue, yellow

* *The jumper wire occupies pins 6 and 7 on the connector.*

Tip: To align the white, 3-pin cable connectors easily, line up the corresponding segments on the white label that you cut when you removed the new suction pump from its packaging.

4. Calibrate the suction pump and controller card. For instructions, refer to *Suction Pump* in Section 12, *Calibration,* in this manual.
5. Return the arm and control head to normal position.
6. Replace the left, right, and rear covers.
7. Plug the power cord connector into the wall receptacle.
8. Turn on the AC Main Switch, located on the rear panel.

Suction Pinch Valve

Accessing the suction pinch valve requires removing the irrigation pump bezel. The following procedures describe how to remove and re-install the irrigation pump bezel and the suction pinch valve.

Tools Needed

You will need a Phillips head screwdriver.

Remove the Irrigation Pump Bezel

1. Turn off the AC Main Switch, located on the rear panel.
2. Unplug the power cord connector from the wall receptacle.
3. Open the irrigation pump latch halfway so that the latch lever stands at the 12 o'clock position.
4. Four ball-end retainers hold the irrigation pump bezel in place. Remove the pump bezel by pulling it straight forward. Refer to Figure 11-27.

Remove the Suction Pinch Valve

1. Remove the console rear and left covers.
2. Disconnect the suction pinch valve from the ultrasonics PCB (J18).
3. Remove the two screws (M4 Phillips) that hold the pinch valve onto the pinch valve collar.
4. Remove the pinch valve electrical leads from the cable restraints.
5. Remove the pinch valve by pulling it forward. Refer to Figure 11-28.

   Note: Ensure that the electrical leads are free to move.

Figure 11-27.
Removing the irrigation pump bezel

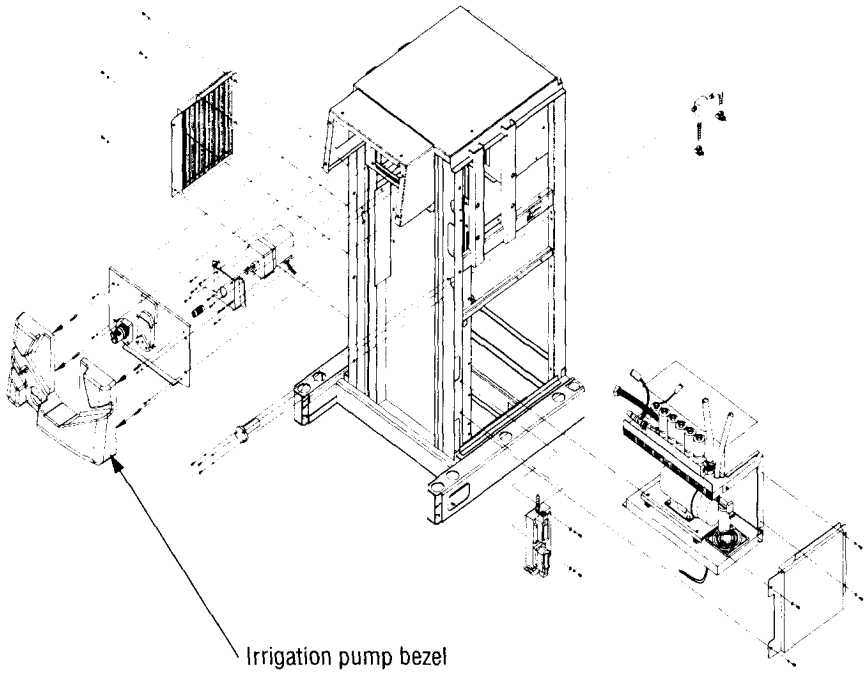
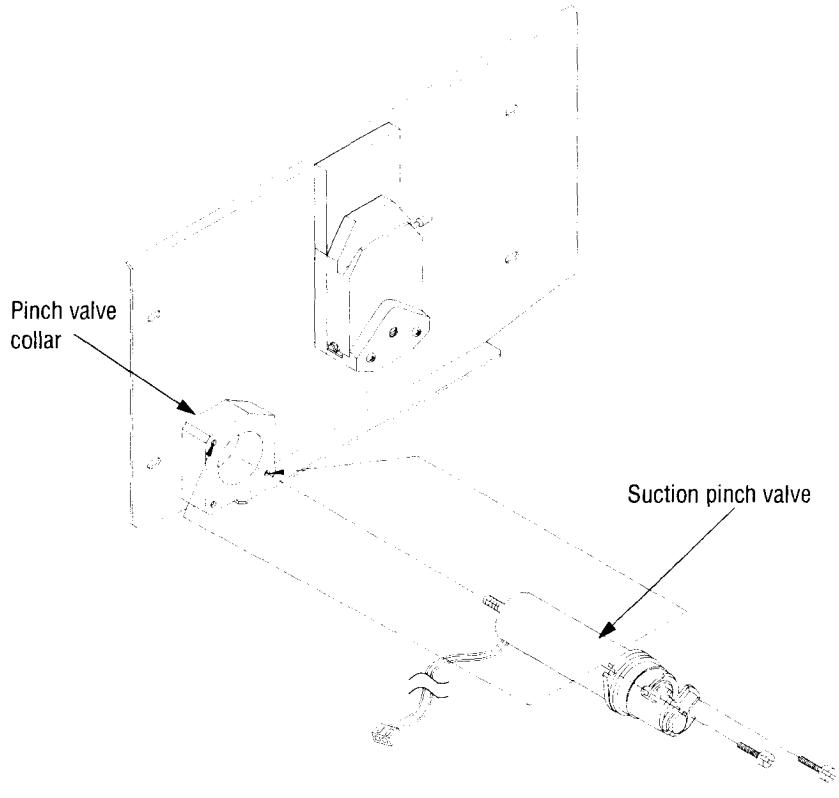


Figure 11-28.
Removing the suction pinch valve



Install the Suction Pinch Valve

1. Replace the pinch valve by pushing it into place.

   Note: Ensure that the electrical leads are free to move.

2. Replace the pinch valve electrical leads on the cable restraints.
3. Replace the two screws (M4 Phillips) that hold the pinch valve onto the pinch valve collar.
4. Connect the suction pinch valve to the ultrasonics PCB (J18).
5. Replace the console rear and left covers.

Install the Irrigation Pump Bezel

1. Align the 4 ball-end retainers that hold the irrigation pump bezel in place. Attach the pump bezel by pushing it straight toward the console.
2. Close the irrigation pump latch by rotating the latch lever clockwise until it reaches the 3 o'clock position.
3. Plug the power cord connector into the wall receptacle.
4. Turn on the AC Main Switch, located on the rear panel.

Irrigation Pump Head and Gear Motor

Accessing the irrigation pump head requires removing the irrigation pump bezel; accessing the irrigation pump gear motor requires removing the bezel and the panel behind it. The following procedures describe how to remove and re-install the irrigation pump bezel, head, and gear motor.

Tools Needed

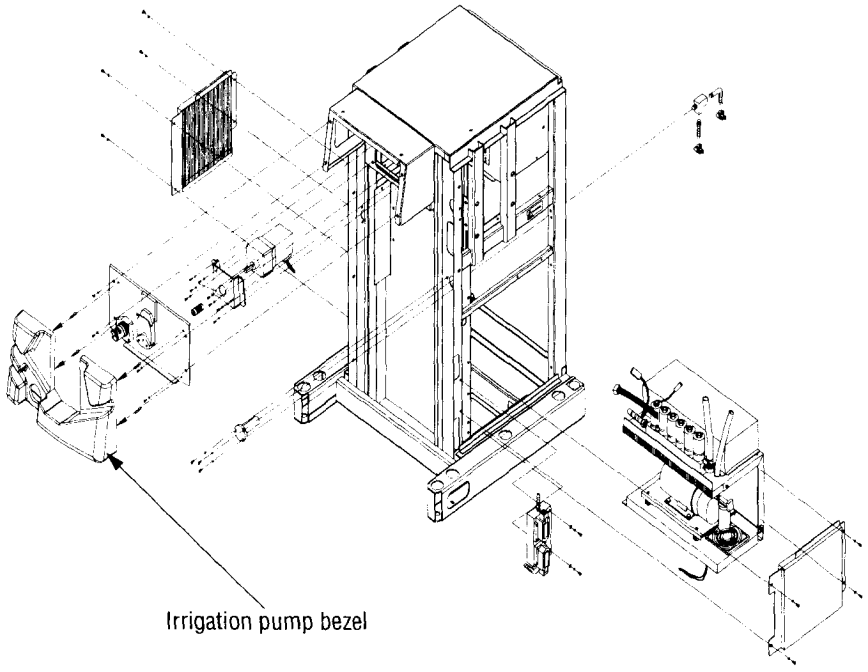
You will need the following tools:

- Phillips head screwdriver.
- Slotted blade screwdriver
- 7 mm nut driver
- 3/32 in. Hex key or Allen wrench.

Remove the Irrigation Pump Bezel

1. Turn off the AC Main Switch, located on the rear panel.
2. Unplug the power cord connector from the wall receptacle.
3. Open the irrigation pump latch half way so that the latch lever stands at the 12 o'clock position.
4. Four ball-end retainers hold the irrigation pump bezel in place. Remove the pump bezel by pulling it straight forward. Refer to Figure 11-29.

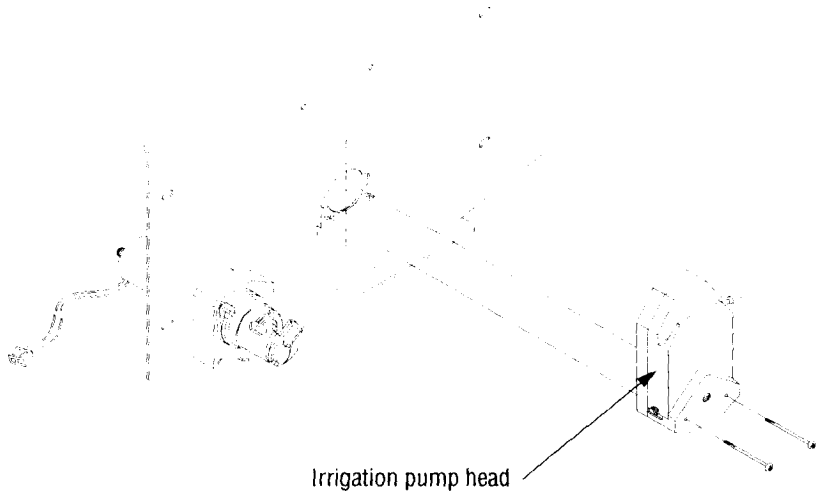
Figure 11-29.
Removing the irrigation pump bezel



Remove the Irrigation Pump Head

1. Remove two screws (8 - 32 buttonhead) from the front of the irrigation pump. These screws fasten the pump head to a flat panel.
2. Pull the pump forward to remove it from the panel.

Figure 11-30.
Removing the irrigation pump head



Install the Irrigation Pump Head

Refer to Figure 11-30.

1. Open the irrigation pump latch completely.
2. View the end of the gear motor coupling, noticing the position of the slot in the end of the coupling. Position the shaft tang in the pump head to match the position of the slot in the gear motor coupling.
3. Insert the shaft tang into the slot on the gear motor coupling.
4. Position the pump head on the panel, making sure that the head is flat against it.
5. Insert two screws (8 - 32 buttonhead), through the front of the pump head.

▶ ***Important***
Do not overtighten the screws. If the screws are too tight, they can crack plastic parts in the pump head.

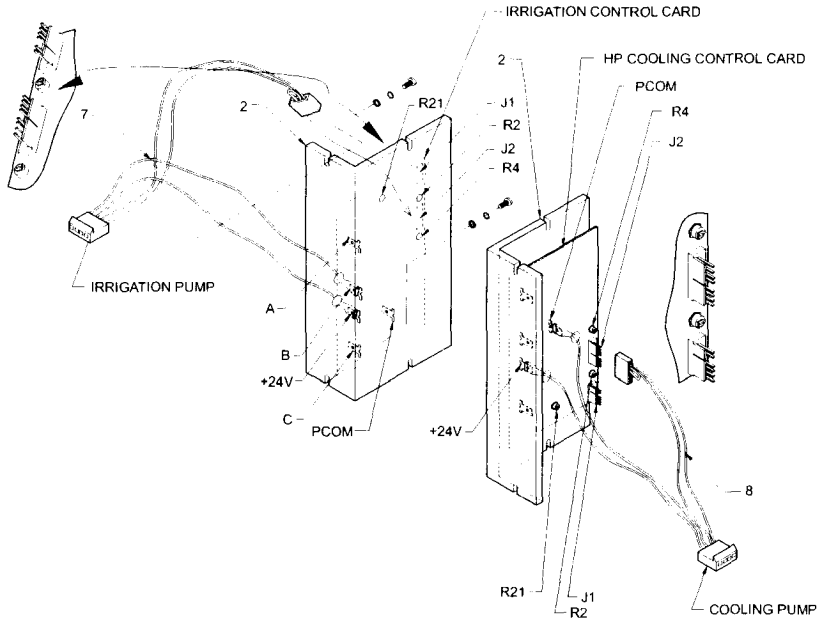
6. Set the screws with a 3/32 in. Hex key or Allen wrench.
7. Rotate the pump shaft by hand to ensure that the shaft tang has seated properly in the gear motor coupling.

Remove the Irrigation Pump Gear Motor

Removing the gear motor requires removing the left side cover and the irrigation pump bezel, but not the pump head.

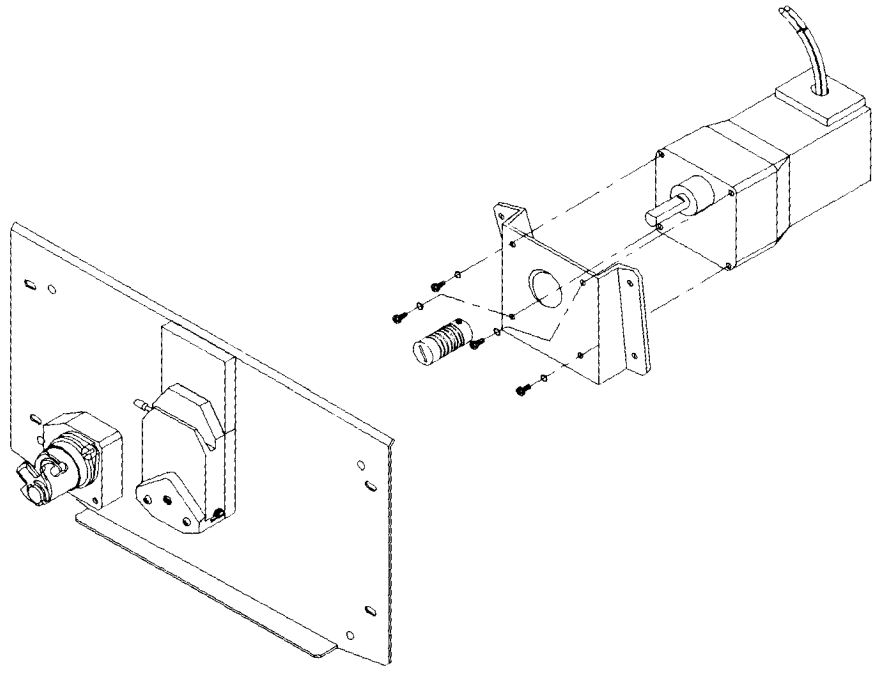
1. Remove the four screws and four lock washers (M5 Phillips) that hold the panel to the console.
2. Pull the panel forward and lay it on top of the console. It is not necessary to remove the suction pinch valve or the irrigation pump head.
3. Remove the four hex nuts (M4), four washers (M4), and four lock washers (M4) from the motor control card bracket.
4. Pull the control card bracket far enough from the frame to disconnect the irrigation gear motor from the control card. Refer to Figure 11-31.

Figure 11-31.
Disconnecting the irrigation pump gear motor from the control card



5. Disconnect the gear motor ground wire from the frame.
6. After disconnecting the gear motor from the control card, push the bracket back in the frame and secure it with a minimum of one M4 hex nut.
7. Remove the four screws and four lock washers (M5 Phillips) that attach the gear motor bracket to the console frame.
8. Pull the gear motor and its bracket forward and remove them from the frame.
9. Remove the four screws (10 - 32 Phillips) that attach the gear motor to the bracket.
10. Remove the gear motor from the bracket. Refer to Figure 11-32.

Figure 11-32.
Replacing the gear motor/pump head coupler on the motor drive shaft



11. Measure the position of the gear motor pump coupler on the motor drive shaft. Remove the coupling from the shaft by loosening the hex drive set screw.
12. Put the coupling on the new gear motor drive shaft, making sure that the coupling is in the same position on the new drive shaft as it was on the old drive shaft.

Install the Irrigation Pump Gear Motor

1. When you have put the coupling on the new gear motor drive shaft, making sure that the coupling is in the same position on the new drive shaft as it was on the old drive shaft, tighten the drive set screw.
2. Position the gear motor on the bracket.
3. Replace the four screws and four lock washers (10 - 32 Phillips) that attach the gear motor to the bracket.
4. Put the gear motor and its bracket into the frame, then push them into position.
5. Replace the four screws and four lock washers (M5 Phillips) that attach the gear motor bracket to the console frame.
6. Remove the hex nut (M4) that secures the control card and bracket to the frame.
7. Pull the control card bracket far enough from the frame to reconnect the irrigation gear motor:

Table 11-8.
Irrigation pump control card connections

Wire or connector	Terminal
6-pin	J1
brown	A
red	B
orange	C

8. Reconnect the gear motor ground wire to the frame.
9. Push the control card bracket back in the frame and secure it with four hex nuts, four washers, and four lock washers (M4).
10. Position the panel on the console frame. Ensure that the tang on the irrigation pump shaft aligns with the motor shaft coupling.
11. Replace the four screws (M5 Phillips) and four lock washers (M5) that attach the panel to the frame.

Replace the Irrigation Pump Bezel

1. Four ball-end retainers hold the irrigation pump bezel in place. Align the retainers with their holes in the console, then push the bezel into place.
2. Close the irrigation pump latch by rotating the latch lever clockwise until it reaches the 3 o'clock position.
3. Plug the power cord connector into the wall receptacle.
4. Turn on the AC Main Switch, located on the rear panel.

Handpiece Flow Sensor

Replacing the handpiece cooling water sensor involves removing the right and rear covers, then accessing and disconnecting the sensor before removing it. Installing the sensor involves reversing the access process.

Tools and Materials Needed

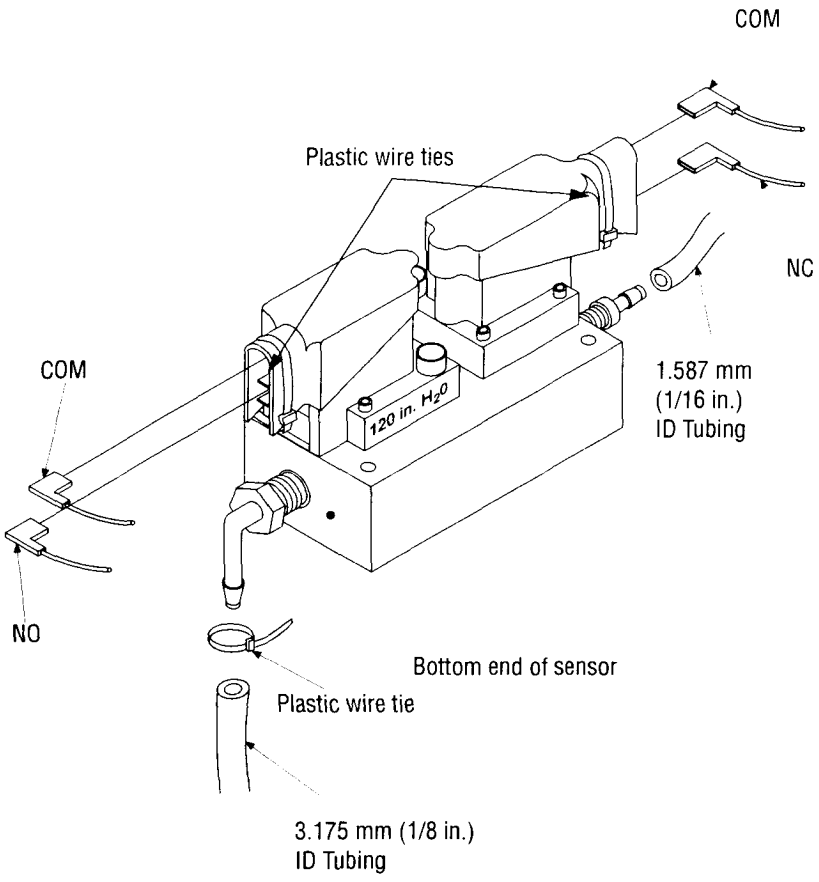
You will need the following tools:

- Phillips screwdriver
- Pliers
- Isopropyl alcohol
- Handpiece cooling water sensor spares kit:
  - One handpiece cooling water sensor assembly
  - Two plastic wire ties (one required)
  - Instructions for use.

Remove the Handpiece Flow Sensor

1. Turn off the AC Main Switch, located on the rear panel.
2. Unplug the power cord connector from the wall receptacle.
3. Remove the right side cover and the rear cover.
4. Disconnect the flow sensor wiring harness from the ultrasonics board at J5.
5. Remove the handpiece cooling water sensor wiring harness from the cable restraint located above the sensor.
6. Remove the 1.587 mm (1/16 in.) ID tube from the upper end of the flow sensor.
7. Remove the two screws (M4 Phillips) that attach the flow sensor to the frame. Lift the flow sensor upwards.
8. Remove the wire tie securing the 3.175 mm (1/8 in.) ID tube to the 90° elbow fitting on the bottom end of the flow sensor.
9. Remove the 3.175 mm (1/8 in.) ID tube from the 90° elbow fitting on the bottom end of the flow sensor.
10. Remove the flow sensor.

Figure 11-33.
Replacing the handpiece flow sensor



Install the Handpiece Flow Sensor

1. Apply isopropyl alcohol to the inside surface of the 3.175 mm (1/8 in.) tube and the outside surface of the 3.175 mm (1/8 in.), 90° elbow tube fitting on the bottom of the flow sensor.
2. Push the 3.175 mm (1/8 in.) ID tube onto the 90° elbow fitting on the bottom of the flow sensor. Make sure to push the tube completely onto the fitting.
3. Secure the tubing with a plastic wire tie.
4. Lower the flow sensor into place and attach it to the frame using two screws (M4 Phillips).
5. Apply isopropyl alcohol to the inside surface of the 1.587 mm (1/16 in.) tube and the outside surface of the 1.587 mm (1/16 in.) tube fitting on the top end of the flow sensor.
6. Push the 1.587 mm (1/16 in.) ID tube onto the tube fitting on the top end of the flow sensor. Make sure to push the tube completely onto the fitting. Make sure, also, that the tube is straight on the fitting.
7. Connect the handpiece cooling water sensor wiring harness to the ultrasonics board at J5.
8. Secure the handpiece cooling water sensor wiring harness inside the cable restraint located above the sensor. The cable restraint will contain two water tubes and the wiring harness.
9. Replace the right side cover and the rear cover.
10. Plug the power cord connector into the wall receptacle.
11. Turn on the AC Main Switch, located on the rear panel.

Cooling Water Pump Tubing

Valleylab offers a cooling water preventive maintenance kit. This kit allows you to perform two tasks:

- Replace the cooling water pump tubing.
- Replace the o-rings on the cooling water reservoir connectors.

Perform each task every 12 months.

This section tells you how to replace the cooling water pump tubing; the following section, *Cooling Water Reservoir O-Rings*, tells you how to replace the o-rings on the cooling water reservoir connectors.

This replacement requires removing the left side cover of the console, then removing the cooling water pump head. The following procedure describes how to remove the cooling water pump head, replace the tubing, and re-install the pump head.

Tools and Materials

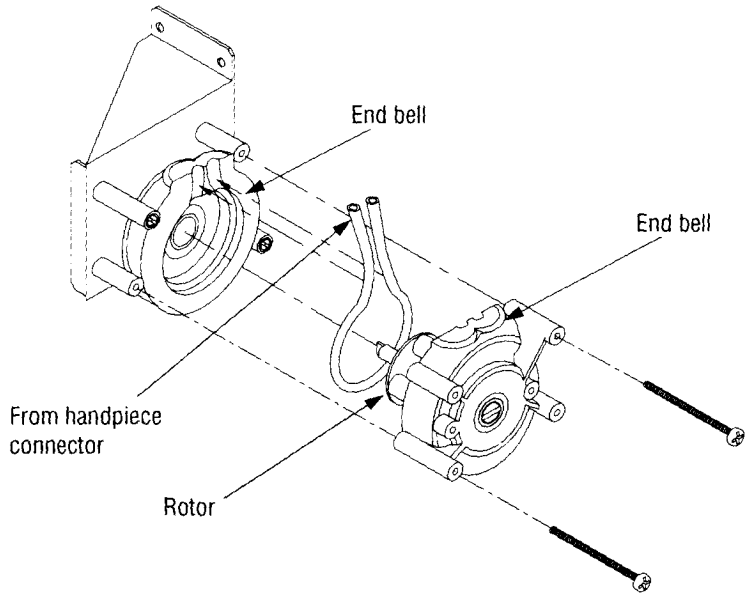
You will need the following items:

- Phillips screwdriver
- Slotted blade screwdriver.
- Cooling water preventive maintenance kit:
  - 4 Pump tubing
  - 4 Two o-rings
  - 4 Four plastic wire ties
  - 4 One packet of silicone lubrication
  - 4 Instructions for use.

Remove the Cooling Water Pump Head

1. Turn off the AC Main Switch, located on the rear panel.
2. Unplug the power cord connector from the wall receptacle.
3. Remove the left side cover.
4. Remove the wire ties. Disconnect the pump tubing from the cooling water tubes at the fittings (2).
5. Remove two screws (8 - 32 Phillips) from the pump head. This releases one-half of the pump head— an "end bell." Pull the released end bell from the console. Refer to Figure 11-34.
6. Remove the tubing from the inside of the released end bell.

Figure 11-34.
Removing the end bell and tubing from the cooling water pump head



Install Tubing and Re-Assemble the Cooling Water Pump Head

1. Hold the released end bell with the tubing retainer grooves pointing down.
2. Center the tubing in the right groove and against the first two rollers. Hold the tubing with your thumb.
3. With the other hand, working counterclockwise, wrap the tubing completely around the rotor, pushing the tubing into the bell assembly. When the tubing has wrapped completely around the rotor, hold the second end in place.
4. Position the end bell with the tubing on the end bell in the console. Ensure that the flat end of the pump drive shaft fits into the slot on the end of the motor coupler.
5. Replace the two screws (8 - 32 Phillips) that attach the end bells.

   Note: If a gap remains between the two end bells after you position them together, the pump head may pinch or cut the tubing. Rotate the pump shaft until the gap disappears.
6. After determining that no gap exists between the end bells, tighten the two screws.
7. Trim the length of the new tubing to reach the cooling water tube fittings.
8. Connect the tubing to the fittings, and replace the wire ties on the fittings. The kit includes two extra wire ties in case you break or lose one.
9. Replace the left side cover.
10. Plug the power cord connector into the wall receptacle.
11. Turn on the AC Main Switch, located on the rear panel.

Cooling Water Reservoir O-Rings

Valleylab offers a cooling water preventive maintenance kit. This kit allows you to perform two tasks:

- Replace the cooling water pump tubing.
- Replace the o-rings on the cooling water reservoir connectors.

Perform each task every 12 months.

This section tells you how to replace the o-rings on the cooling water reservoir connectors; the previous section, *Cooling Water Pump Tubing*, tells you how to replace the cooling water pump tubing.

O-Rings on the Cooling Water Reservoir Connectors

This replacement requires removing the cooling water reservoir from the console, then removing the o-rings on the reservoir connectors. The following procedure describes how to remove the reservoir, remove the used o-rings, install the new o-rings, and re-install the reservoir.

1. Press the cooling water reservoir release button (just above the reservoir) on the arm housing to release the fittings inside the housing.
2. Slide the reservoir toward the rear of the console.
3. Remove the o-ring on each male connector on the cooling water reservoir. Refer to Figure 11-35.

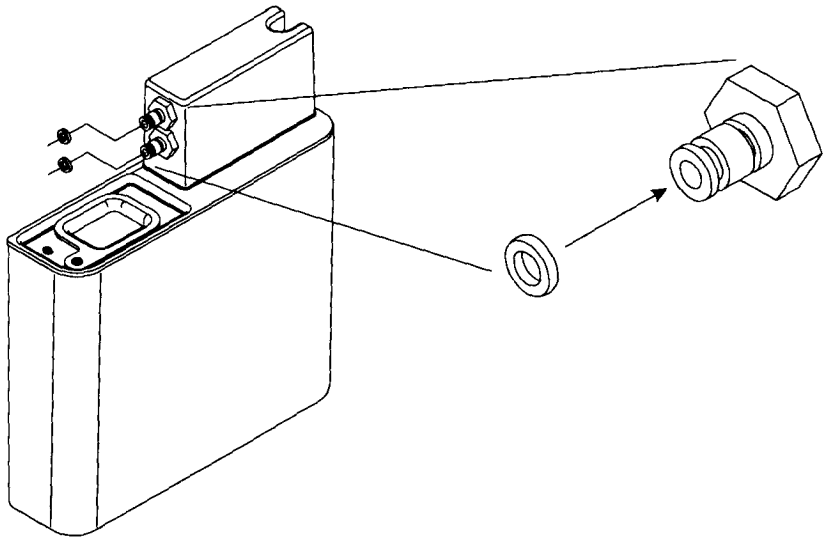


Figure 11-35.
O-rings on cooling water reservoir connectors

4. Open (tear or cut the end) the packet of silicone lubricant.
5. Apply the silicone lubricant to the two o-rings in the cooling water preventive maintenance kit.
6. Slide one o-ring over the end and into the groove at the distal end of each male connector on the cooling water reservoir. Refer to Figure 11-35.
7. Re-install the reservoir: Slide it into the slot on the console side panel until it snaps into place.

Fuses

You must change the fuses (located on the rear panel) if either of the following situations occurs:

- A fuse burns out
- Your facility receives 95 to 120 V power.

Tools needed

You will need a small slotted blade screwdriver.

Procedure

1. Using the screwdriver, turn the fuse cover counter clockwise (about 45°). The fuse holder pops loose.
2. Remove the fuse holder from the rear panel.
3. Replace the fuse:

Table 11-9. *Fuse values*

Volts	Amps	Type
220-240 V	T5A	Time Delay (default)
95-120 V	T10A	Time Delay

4. Insert the holder, and turn the cover clockwise.

Calibration

In this section:

- Tools/equipment needed for calibrations
- DC bias power supply
- Suction pump
- Motor for the cooling water pump.

For Your Information

In the CUSA EXcel system, several components may require calibration. This section describes how to do the calibrations.

In most cases, you need to calibrate a component only when you replace it. These procedures stand alone; that is, you can use one without reference to others.

Warning

High Current Hazard Do not touch the ultrasonics PCB heat sink while the CUSA EXcel system is energized. The heat sink is isolated from ground, and can deliver very high current, resulting in injury.

Tools/Equipment Needed for Calibrations

The calibrations require one or more of the following tools:

- Tachometer
- Irrigation bottle with fluid and administration set
- Digital multimeter, Fluke 87 or equivalent
- Vacuum gauge with T fitting and hose, 0–30 in. Hg
- Ashcroft 5 in. Dial-Grade 3A 0.25% or equivalent
- Suction canister
- Contamination guard
- Slotted blade screwdriver
- Phillips screwdriver.

DC Bias Power Supply

1. Leave all power off.
2. Remove the rear panel.
3. Put DVM leads between pins 1 and 6 of the output jack on the DC bias power supply. You will find it on the AC input assembly (facing the rear of the console, you see it on the left side of the assembly).
4. Turn on the AC Main Switch (rear panel) and the System Power Switch (front panel).
5. Adjust the potentiometer to 4.7 Vdc (-0 + 0.05).
6. Turn off the System Power Switch (front panel) and the AC Main Switch (rear panel).
7. Apply Torque Seal compound (Valleylab part number 232 301 176) to the adjustment screw of the potentiometer.

Suction Pump

1. Remove the left cover.
2. Remove the left end panel from the suction pump enclosure.
3. On the control panel, set the unit to Run mode.
4. Apply the digital tachometer to the suction pump motor shaft.
5. Adjust the Max. speed pot on the suction pump controller card so that the motor operates at 3200 ± 20 rpm.
6. On the control panel, set the unit in Standby mode.
7. With the digital tachometer, verify that motor speed is greater than 1200 rpm.
8. Apply Torque Seal compound (Valleylab part number 232 301 176) to the Max. speed pot.
9. On the suction pump enclosure, replace the left end panel.
10. On the console, replace the left cover.

Motor for the Cooling Water Pump

Set Up

Before calibrating the motor for the cooling water pump, prepare the cooling water system:

1. Fill and attach the cooling water reservoir.
2. Attach a handpiece to the console.
3. Turn on the AC Main Switch (rear panel) and the System Power Switch (front panel).

   When you turn on the System Power Switch, the CUSA EXcel system begins to circulate cooling water through the handpiece. This takes about one minute to complete. While the system is performing this task, the amber Wait indicator flashes and the Cooling Water indicator (upper right on the control panel) illuminates.

   When the system turns the Wait and Cooling Water indicators Off, it turns On the suction pump, the Test button LED, and the Prime button LED. The cooling water system is ready for calibration.
4. Prime the system: Press the Prime button (blue box on a black button at the top of the Irrigation display).

   Watch for irrigation fluid to drip from the handpiece tip. Priming takes about one minute.

   After priming, the system automatically turns the Prime button LED Off, then goes to the Standby status.

Procedure

1. Remove the left cover from the CUSA EXcel console.
2. On the control panel, set the unit to Run mode.
3. While the unit is in Run mode, apply the digital tachometer to the cooling water pump shaft.
4. Adjust the Max. Speed trim pot "R2," located between J1 and J2 on the control card for the cooling water motor, to operate the motor speed at the maximum speed attainable within the range of 61 to 68 rpm.
5. On the CUSA EXcel console, replace the left cover.

Repair Policy

In this section:

- Return equipment for service:
  - Obtaining a return authorization number
  - Returning the console
  - Returning the handpiece
  - Returning circuit boards
  - Ordering replacement parts
- Valleylab service centers.

Return Equipment for Service

Before you return CUSA equipment, call your Valleylab representative for help. If the representative tells you to send the equipment to Valleylab, first obtain a Return Authorization Number. Then clean the equipment and ship it to Valleylab for service.

Obtaining a Return Authorization Number

Call Valleylab Customer Service for your area (refer to "Valleylab Service Centers" in this section) to obtain a Return Authorization Number. Have the following information ready when you call:

- Hospital/clinic name/customer number
- Technician's name
- Telephone number
- Department/address, city, state, and zip code
- Model number
- Serial number
- Description of the problem
- Type of repair to be done.

Attach a tag with this same information to the equipment when you ship it for service.

Returning the Console

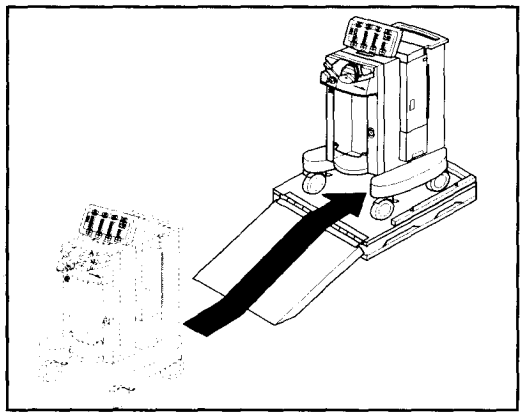
It is very important that you use the proper materials—original packaging materials, if possible—and the proper packing procedures to ship the console. If, in Valleylab's judgement, you fail to use the proper packing procedures or if you use improper packaging materials to return the console, you may void the warranty on this system.

Tools and Materials Needed:

- Shipping materials:
  - 4 Pallet
  - 4 Corrugated shipping crate, cover, tray, and ancillary container
  - 4 Right foam cushion
  - 4 Left foam cushion
  - 4 Top lock cushions (2)
  - 4 Bottom lock cushions (2)
  - 4 Foam head cushion
- Poly bag 76.2 cm x 152.4 cm x 66 cm
- Poly bag 25.4 cm x 35.6 cm
- Poly banding, approximately 20 m
- Banding seals or banding buckles (5)
- Box edge protectors (12)
- Staple gun with 1/2 in. staples
- Pliers (optional).

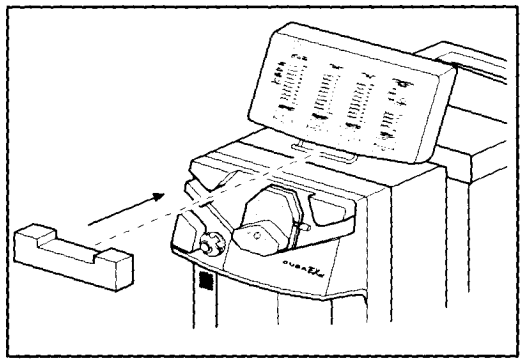
Procedure

1. Position the pallet with the ramp down and all other materials removed.
2. Roll the console up the ramp. If the rear casters are unlocked, be sure that you do not allow the console to roll off the side of the ramp.

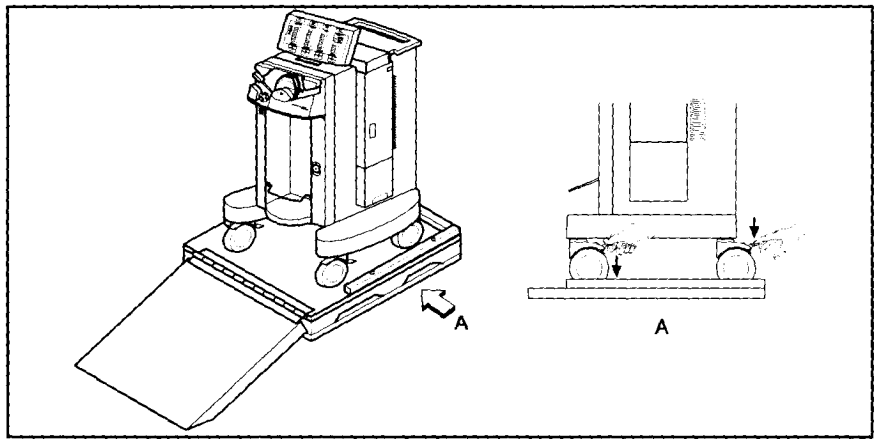


3. Put the power cord inside a polyethylene bag, then secure the cord and bag with a wire tie. Put the bagged power cord on the footswitch storage shelf in the console rear.

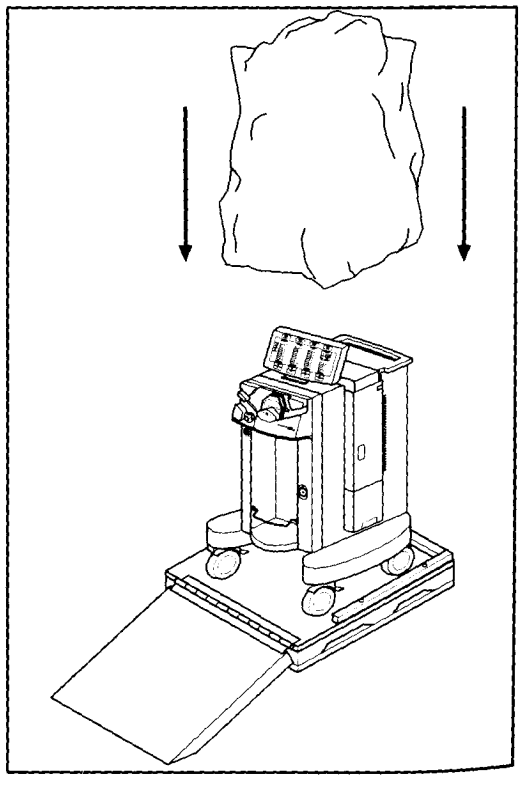
4. Raise the arm and control panel, then place the U-shaped foam cushion under the control panel. Lower the arm, locking the control panel into the foam cushion.



5. Lock the front (brake) casters and the rear (directional) casters by pushing each lock lever downward.



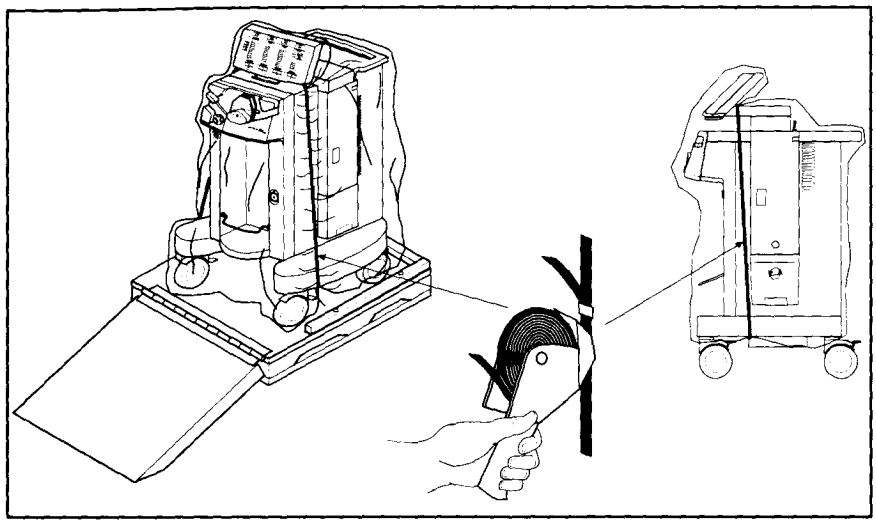
6. Place the clear plastic bag over the console.



7. Route a vertical band over the clear plastic bag:
   a. Over the top of the arm
   b. Around the left side of the console
   c. Through the footswitch bracket on the bottom of the console
   d. Around the right side of the console.

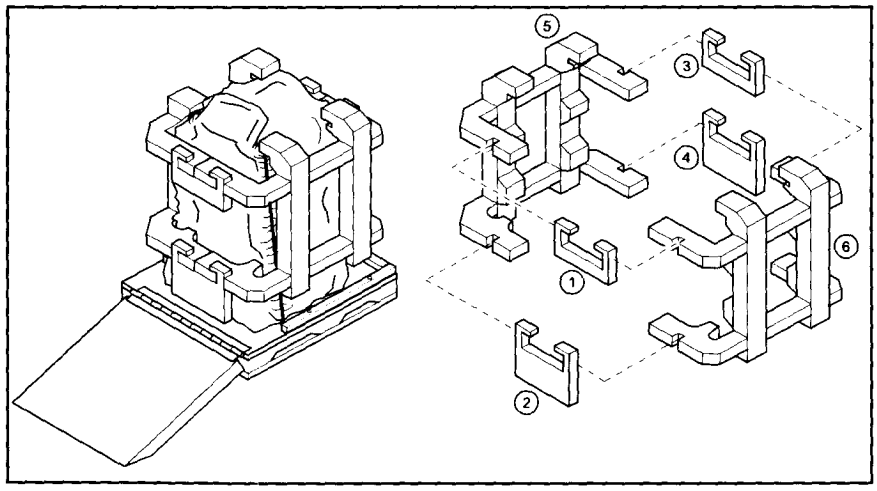
   Be sure the clear plastic bag does not bend the reference cards in the control panel.

   Secure the band with one banding seal.



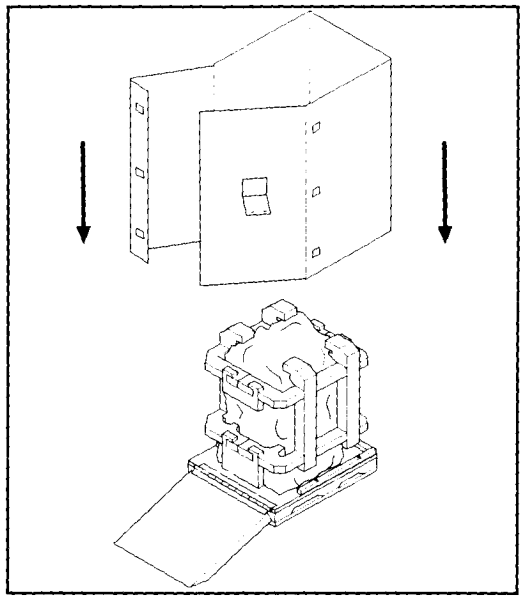
8. Attach the right (5) and left (6) foam cushions to the console.

   Attach the four interlocking foam pieces (1–4) from the foam cushion around the console (refer to the following figure).

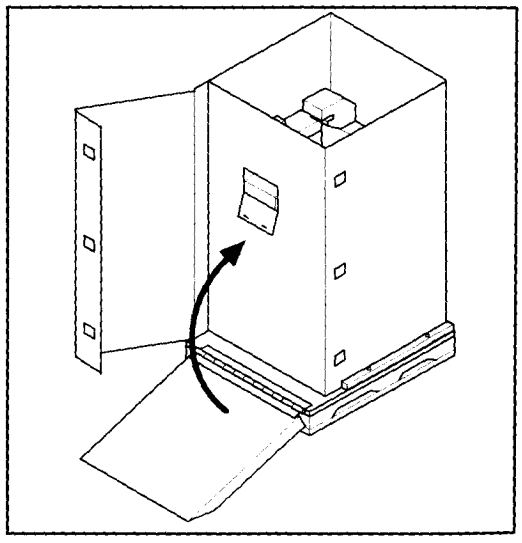


9. Position the corrugated crate walls on the pallet so that the front of the crate is on the same side of the pallet as the ramp.

   Close the right front panel of the corrugated crate around the console.



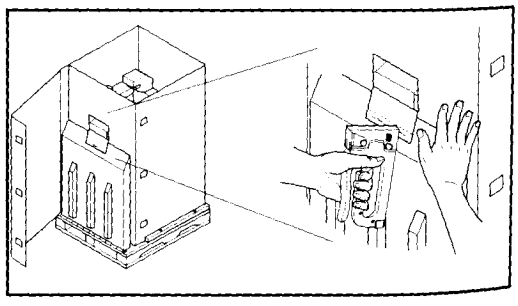
10. Raise the ramp.



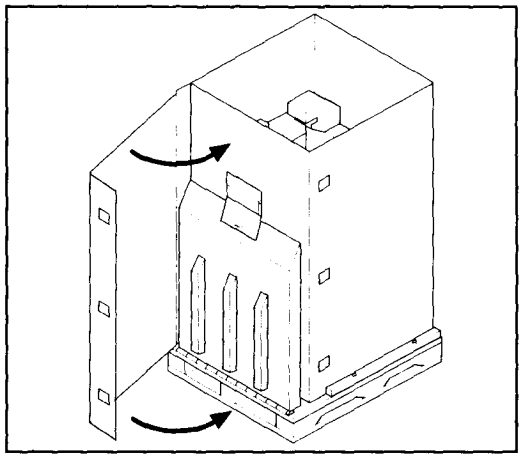
Caution

To prevent the ramp from falling and causing injury, be sure to hold the ramp in the up position while stapling the corrugated tab that secures it to the crate.

11. Secure the ramp to the corrugated tab on the right front panel with two 1/2 in. staples.



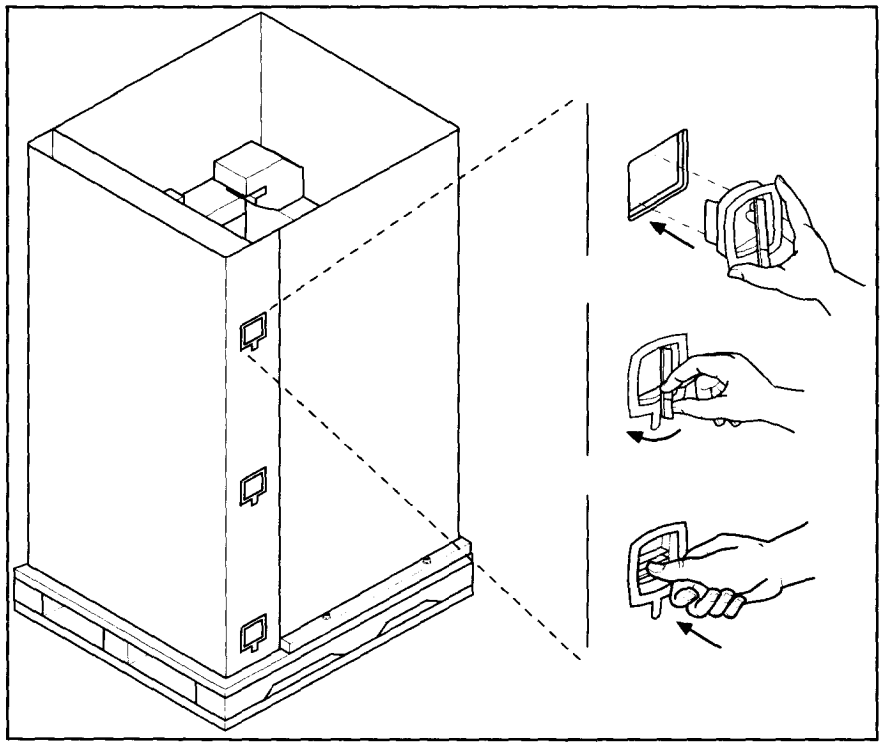
12. Close the left front panel around the front of the console and the right front panel.



13. Secure the crate closed by locking the three plastic clips into the slots on the side of the corrugated crate. Refer to the next figure.

    a. With the clip oriented so that the tab is on its bottom edge, insert the clip into the slot. Push hard enough that the flange on the clip rests firmly on the outside of the left front panel and the leading edge of the clip is inside the corrugated crate.

    b. Push the horizontal bars inside the clip toward the crate until the bars lock into place.



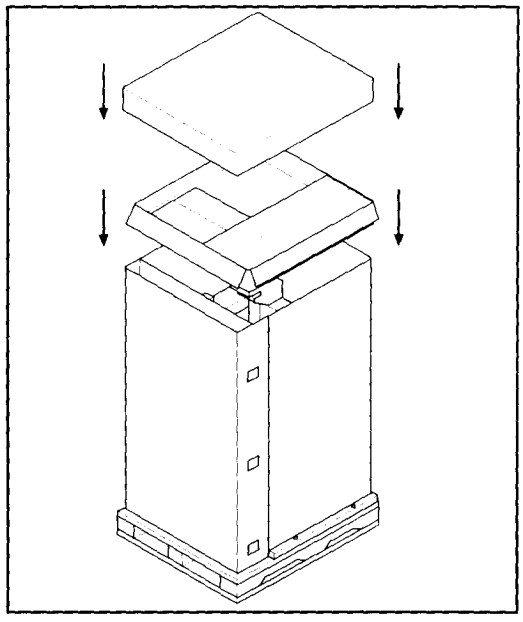
14. Pack the CUSA EXcel footswitch into its original packaging, and seal the packaging with tape.

15. Place the sealed footswitch packaging into the corrugated tray.

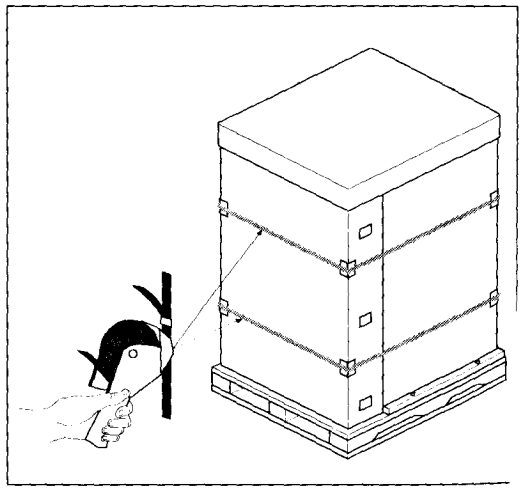
    Note: If returning a handpiece, secure it into its original packaging, then place the handpiece packaging into the corrugated tray.

    Install the tray in the top of the corrugated crate.

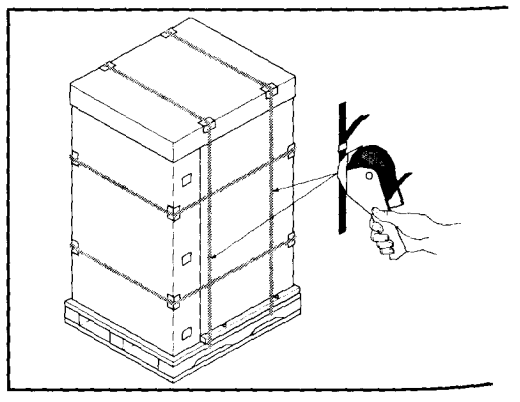
16. Install the cover on the corrugated crate.



17. Secure the shipping crate closed with two horizontal bands, two band seals, and eight box edge protectors.



18. Secure the shipping crate to the pallet with two vertical bands, two band seals, and four box edge protectors.



Returning the Handpiece

Clean, disinfect, and sterilize the handpiece before you package it for shipping.

Package the handpiece and handpiece cable in a way that will protect the handpiece and handpiece cable connector from damage.

Package each handpiece in a separate packaging container.

Returning Circuit Boards

When packaging circuit boards use the following guidelines:

- Whenever possible, use the same packing materials in which you received the circuit board.
- Place each circuit board or subassembly in an electrostatic discharge (ESD) bag or container.
- Provide a separate packing container for each circuit board.
- When returning a subassembly with electrical components, use at least four inches of tightly packed, industry approved, shock absorbing, ESD packing material on all sides, including the bottom.

Ordering Replacement Parts

When ordering replacement parts for the console, include this information:

- Model number (located on the label on the CUSA system rear panel)
- Serial number (located on the label on the CUSA system rear panel)
- Part number (Refer to the Replacement Parts section in this manual).

When ordering replacement parts for the handpiece, include the serial number (located on the handpiece connector).

Valleylab Service Centers

Valleylab
Boulder, Colorado, 80301-3299
USA
Ph: 303-530-2300
Toll Free: 800-255-8522

Tyco Healthcare Nederland B.V.
Technical Service Center
De Beverspijken 37
5221 EE 's-Hertogenbosch
THE NETHERLANDS
Ph: 073-6312412
Fax: 073-6314540

Auto Suture France S.A.
2, rue Denis Diderot
La Clef de Saint Pierre
78990 Elancourt, FRANCE
Ph: 33 (0)1 30 79 80 40
Fax: 33 (0)1 30 79 85 73

Tyco Healthcare Deutschland
Tempelsweg 26
47918 Tonisvorst, GERMANY
Ph: 49 (0)2151 7096 92
Fax: 49 (0)2151 7096 67

For the UK, Europe,
Middle East & Africa:
Tyco Healthcare UK Limited
Valleylab Service Centre
Unit 1a
Corinium Industrial Estate
Raans Road
Amersham
Bucks. HP6 6YJ
UNITED KINGDOM
Ph: 44 (0)1494 789200
FAX: 44 (0)1494 789239

Tyco Healthcare Italia SpA
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Ph: 39 02 212181
Fax: 39 02 2640059

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Barcelona
SPAIN
Ph: 34-93-680-3370
Fax: 34-93-680-2457

Tyco Healthcare Belgium B.V.
Generaal De Wittelaan 9/5
B-2800 Mechelen
BELGIUM
Ph: 32-15-298111
Fax: 32-15-217987

Tyco Healthcare Austria GmbH
Jochen Rindt Str. 37
A-1230 Vienna
AUSTRIA
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Fax: 43-1-615-3808

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Auto Suture Japan
Regulatory Affairs Department
Technical Support Section
Customer Call Center
1-2-20 Heiwajima Ota-ku Tokyo-to JAPAN
Toll Free : 0120-073-008
Ph: 03-3764-0733
Fax: 03-3764-0744

Auto Suture Company, Canada
4490 Garand Street
Ville St. Laurent
Quebec, CANADA H4R 2A2
Ph: 514-334 -7602
Fax: 514-331-5983

Service Parts Lists

In this section:

- Ordering replacement parts
- Replacement parts
- Electronics parts.

Ordering Replacement Parts

When ordering replacement parts for the console, include this information:

- Model number (located on the label on the CUSA system rear panel)
- Serial number (located on the label on the CUSA system rear panel)
- Part number.

When ordering replacement parts for the handpiece, include the serial number (located on the handpiece connector).

Replace all components with parts of identical construction and value. Replacement part ratings and tolerances must be equal to, or better than, original. Substituting lower grade parts can adversely affect system performance.

If you have any questions about ordering parts, please call the Valleylab Service Center nearest you.

Replacement Parts

Handpiece Cooling

Table 14-1.
Handpiece cooling replacement parts

Reference Designator	Description	Valleylab Part Number
	Isolation Diaphragm Valve	243 500 002
	Handpiece Cooling Sensor Assembly	S202 750 084
	Cooling Water Reservoir Assembly	S202 750 094
	Cooling Water Coupling, Console, In	243 500 009
	Cooling Water Coupling, Console, Out	243 500 259
	Cooling Water Tubing, 3.175 mm (1/8 in.) ID	625 028 007
	Cooling Water Pump Gear motor, 18:1 Ratio	220 250 000
	Cooling Water Pump	577 014 003
	Coupling, Pump/Motor	223 400 735
	Cooling Water Preventive Maintenance Kit	S911 000 014

Irrigation

Table 14-2.
Irrigation replacement parts

Reference Designator	Description	Valleylab Part Number
	Irrigation Pump Gear motor, 25:1 Ratio	220 250 004
	Irrigation or Cooling Motor Control Card	207 000 206
	Irrigation Pump Head	243 500 000
	Coupling, Pump / Motor	223 400 735
	IV Pole	223 400 733

Miscellaneous

Table 14-3.
Miscellaneous replacement parts

Reference Designator	Description	Valleylab Part Number
	CUSA EXcel Footswitch	150 000 090
	O-rings Maintenance Kit	260 650 000
	Torque Seal	232 301 176
	23 kHz Handpiece/Tip Maintenance Kit	C0023
	36 kHz Handpiece/Tip Maintenance Kit	C0036
	International Language Kits	
	Portuguese (Brazilian)	S945 101 324
	German	S945 101 319
	English	S945 101 336
	Spanish	S945 101 323
	French	S945 101 317
	Italian	S945 101 321
	Dutch	S945 101 318
	Swedish	S945 101 320
	Russian	S945 101 322
	Chinese	S945 101 326
	Japanese	S945 101 325

Power

Table 14-4.
Power replacement parts

Reference Designator	Description	Valleylab Part Number
	Power Switch, Mains	243 080 001
	Power Supply, 40W, 5 VDC	207 000 223
	Fuse, 5X20mm, 5 AMP, 250 V, Time Delay	215 100 084
	Fuse, 5X20mm, 10 AMP, 250 V, Time Delay	215 100 082
	Standby Switch, VAC	243 080 005

Suction

Table 14-5.
Suction replacement parts

Reference Designator	Description	Valleylab Part Number
	Vacuum Pump	220 250 006
	Suction Control Valve	243 500 001
	Suction Pinch Valve	243 500 006
	Contamination Guard	C0005

Electronic Parts

Table 14-6.
Printed circuit board spares

Reference Designator	Description	Valleylab Part Number
	Display Board	207 500 633
	Ultrasonics and Machine Control Printed Circuit Boards	S202 750 281
	CUSA Dual 24 V Power Supply Board	S202 750 280

Ultrasonics PCB Parts

Resistors

Table 14-7.
Ultrasonics board parts—resistors

Reference Designator	Description	Valleylab Part Number
R21, 27, 31, 32, 34, 54, 56	Res, MF, 2 W, 5%, 1 Ohm, Axial	234 200 084
R22,33,35,53, 55	Res, MF, 3 W, 1%, 100 Ohm, Axial	234 200 085
R28, 30	Res, MF, 3 W, 5%, 130 Ohm, Axial	234 200 086
R117, 118, 119, 120, 158, 159	Res, MF, 1 W, 1%, 4 Ohm, Axial	234 200 087
R155, 156	Res, WW/MF, 10 W, 5% 56 Ohm	234 400 291
R3,6	Res, MF, 2 W, 5%, 47 Ohm	234 200 102
RV1	Potentiometer, 10k Ohm	236 200 112

Diodes/Voltage Suppressors

Table 14-8.
Ultrasonics board parts—diodes

Reference Designator	Description	Valleylab Part Number
CR11, 12	Diode, SD101C through hole	239 600 647
CR9, 10	Diode, Zener IN5245	239 600 650
CR8	Diode, Rectifier IN4001	239 700 069
CR6	Transient Voltage Suppressor 1.5KE6.8	239 600 649

Table 14-9.
Ultrasonics board parts—FETs

FETs

Reference Designator	Description	Valleylab Part Number
Q4, 7, 8, 9, 12, 13	FET, BSS110	239 200 069
Q2, 3, 5, 6, 11, 14	2N7000 N Channel MOS	239 200 071
Q1	FET, P Channel RFP10P03L	239 200 072

Table 14-10.
Ultrasonics board parts—integrated circuits

Integrated Circuits

Reference Designator	Description	Valleylab Part Number
U18	IC, Timer LM555CN	210 006 001
U19, 3, 6	UDN2596A	210 100 053
U14	IC, 74HC00	210 230 007
U21	DG201A	210 250 102
U28	IC, Flip-Flop MC1417B	210 250 103
U8	LM78L05	210 300 109
U13	LF353	210 400 037
U17	IC, LM 393 AN	210 410 004
U11	AD570JD	210 740 014

Table 14-11.
Ultrasonics board parts—connectors

Connectors

Reference Designator	Description	Valleylab Part Number
J6	Connector PCB, 2 CKT, 0.256 in. centers	208 160 052
J4	Connector PCB, 3 CKT, 0.256 in. centers	208 160 053
J15	Connector PCB, 4 CKT, 0.256 in. centers	208 160 054
J3	Connector PCB, 5 CKT, 0.256 in. centers	208 160 055
J1	Connector PCB, 10 CKT, 0.256 in. centers	208 160 060
J14	Connector PCB, 6 CKT, 0.100 in. centers	208 200 321
J12	Connector PCB, 40 CKT Dual Row, Ribbon	208 200 323
J7	Connector PCB, 12 PIN, Dual Row, 0.100 in. centers	208 200 382
J9	Connector PCB, 20 PIN, Dual Row, Ribbon	208 200 383
J5, 10, 11, 18	Header, 2 PIN, 0.100 in. centers, Lock	208 200 389
J16, 17, 19	Header, 4 PIN, 0.100 in. centers, Lock	208 200 390
J8, 13	Header, 2 PIN, 0.295 in. centers, Lock	208 200 391
J2	Connector CIR Receptacle, 7 CKT	208 300 818

Table 14-12.
Ultrasonics board parts—miscellaneous

Miscellaneous

Reference Designator	Description	Valleylab Part Number
All TPs	Test Point	208 200 284
6	Contact Socket CPC PC MO	208 200 378
All JMPs	Jumper, 0.100 in. center, Wire	208 400 117
5	Socket FET Single Pin	208 500 106
7	Nut Plate, Footswitch Connector	223 301 195
2	Heatsink, TO-220 Pkg.	223 400 757
4	Nut Hex 4-40 STL NKL PLD	224 011 023
K1	Relay Reed, Ultramini, SPST	230 017 010
3	Screw, Pan Hd, Phil 4-40 X 1/2	237 100 680
SW1, 2, 3, 4	Dip Switch	243 080 004
U27	TRANSF, 24 V dc to 15 V dc Converter	251 200 086
All DFs	Filter, EMI, 1MHz FC, 3 Pins	251 400 011

Warranty

Valleylab, a division of Tyco Healthcare Group LP, warrants each product manufactured by it to be free from defects in material and workmanship under normal use and service for the period(s) set forth below. Valleylab's obligation under this warranty is limited to the repair or replacement, at its sole option, of any product, or part thereof, which has been returned to it or its Distributor within the applicable time period shown below after shipment of the product to the original purchaser and which examination discloses, to Valleylab's satisfaction, that the product is defective. This warranty does not apply to any product, or part thereof, which has been repaired or altered outside of Valleylab's factory in a way so as, in Valleylab's judgment, to affect its stability or reliability, or which has been subject to misuse, negligence, or accident. **Shipping this product without proper packaging materials or failing to use proper packing procedures, in Valleylab's judgement, may void this warranty.**

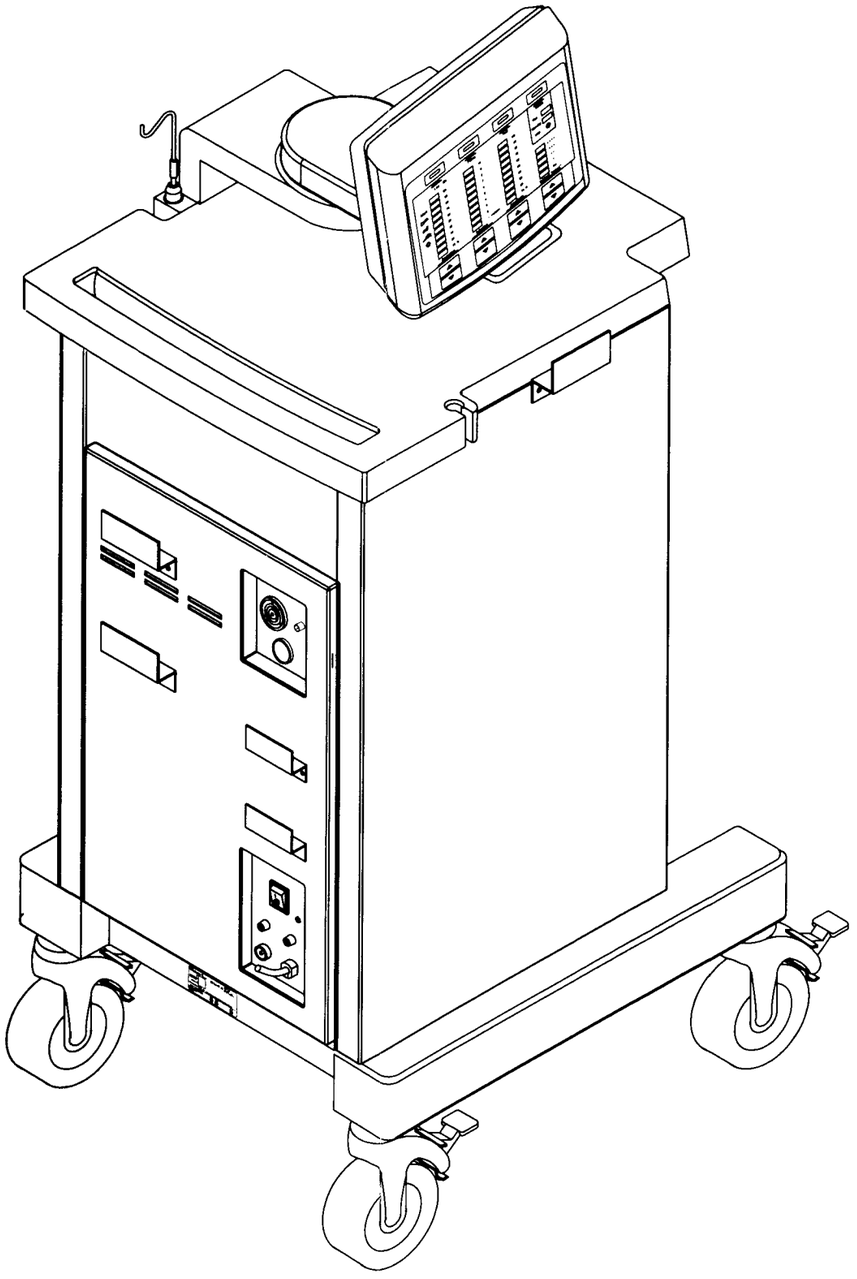
The warranty periods for Valleylab's products are as follows:

CUSA EXcel Console	One year from date of shipment
23 kHz Straight and Angled Handpieces, and 36 kHz Straight Handpiece	One year from date of shipment

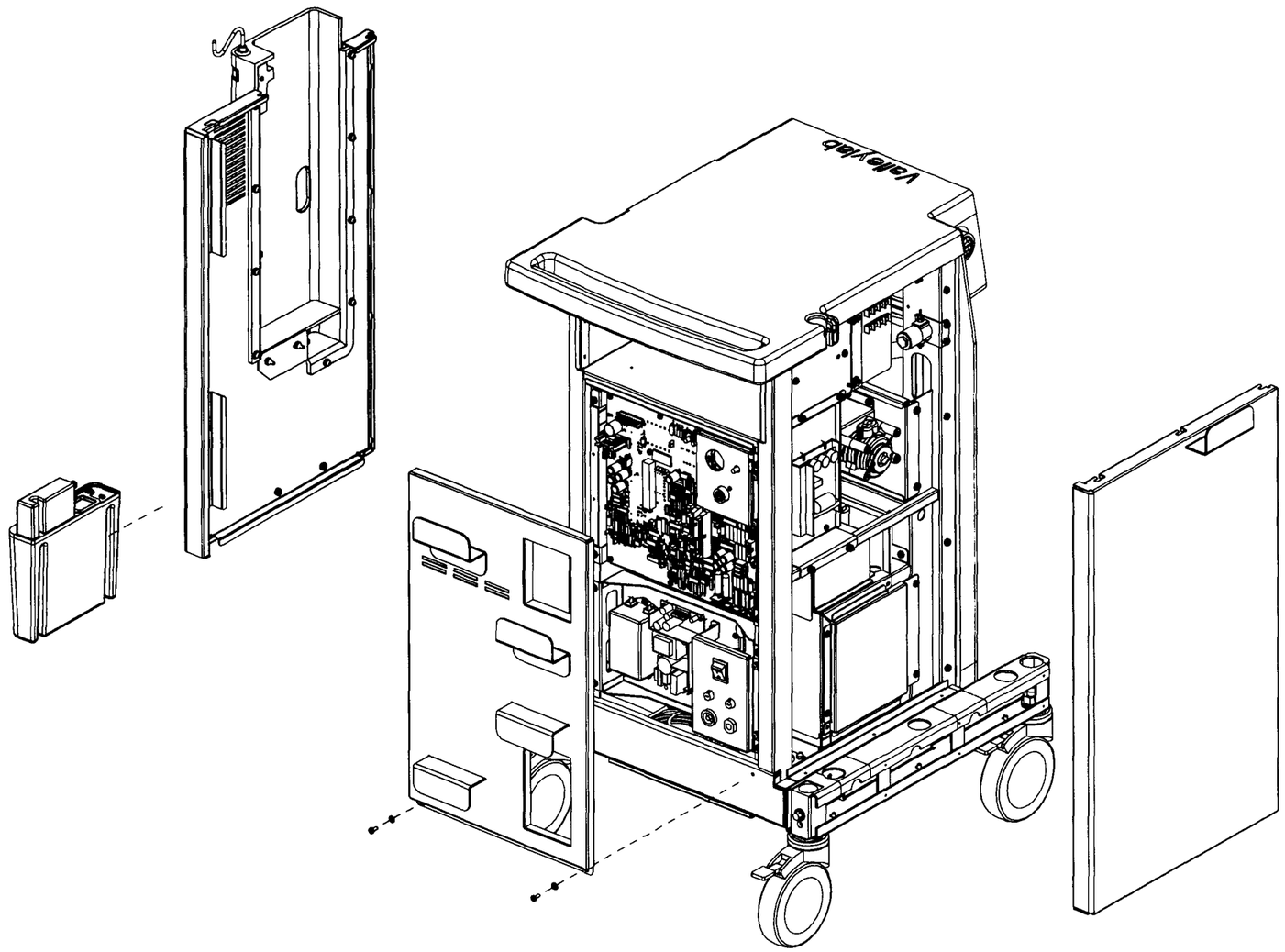
This warranty is in lieu of all other warranties, expressed or implied, including, without limitation, the warranties of merchantability and fitness for a particular purpose, and of all other obligations or liabilities on the part of Valleylab. Valleylab neither assumes nor authorizes any other person to assume for it any other liability in connection with the sale or use of any of Valleylab's products. Notwithstanding any other provision herein or in any other document or communication, Valleylab's liability with respect to this agreement and products sold hereunder shall be limited to the aggregate purchase price for the goods sold by Valleylab to customer. There are no warranties which extend beyond the terms hereof. Valleylab disclaims any liability hereunder or elsewhere in connection with the sale of this product, for indirect or consequential damages.

This warranty and the rights and obligations hereunder shall be construed under and governed by the laws of the State of Colorado, USA.

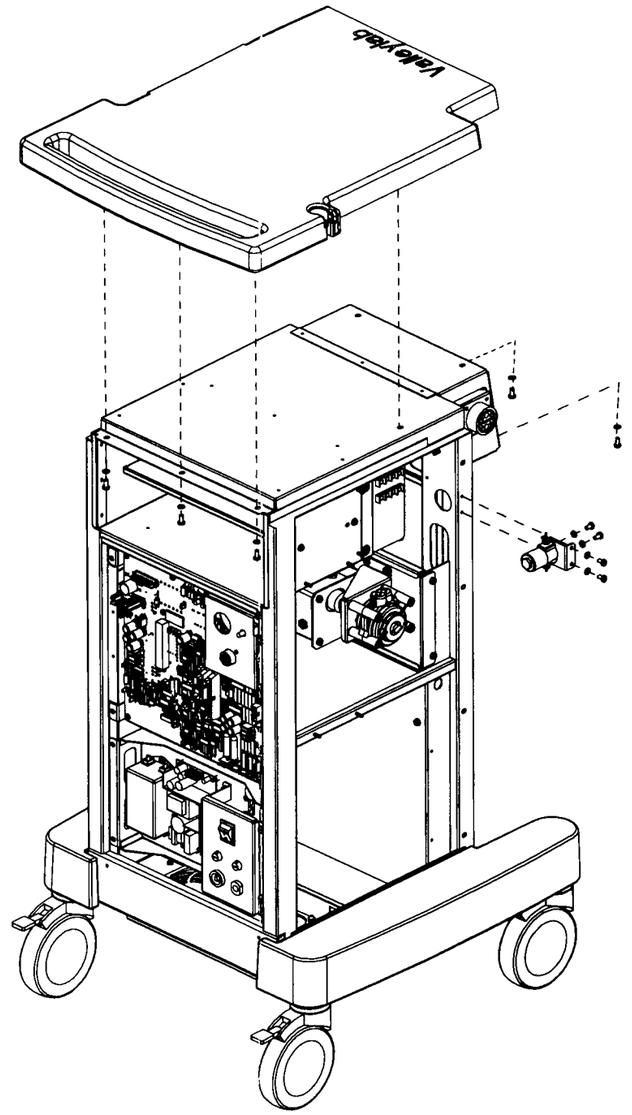
Valleylab, its dealers and representatives, reserve the right to make changes in equipment built and/or sold by them at any time without incurring any obligation to make the same or similar changes on equipment previously built and/or sold by them.



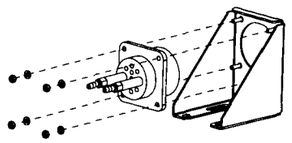
Schematic 1. *The console rear and left side*



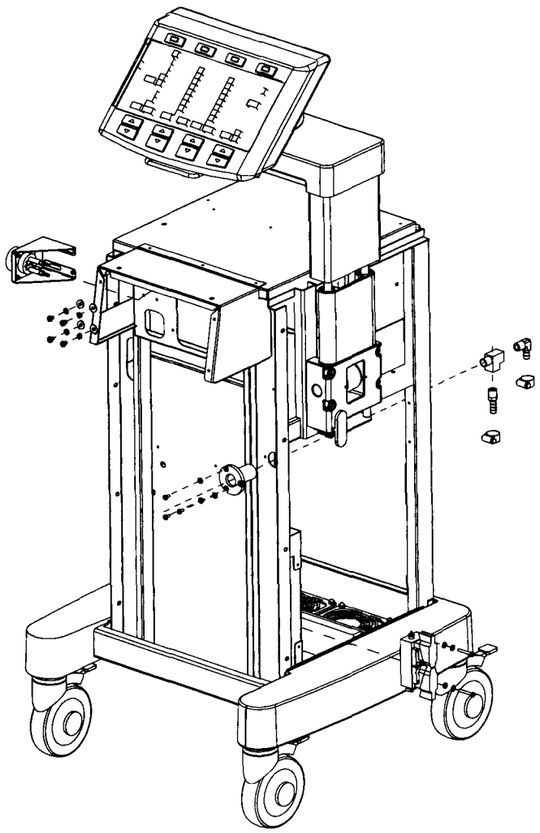
Schematic 2. *Console covers and panels*

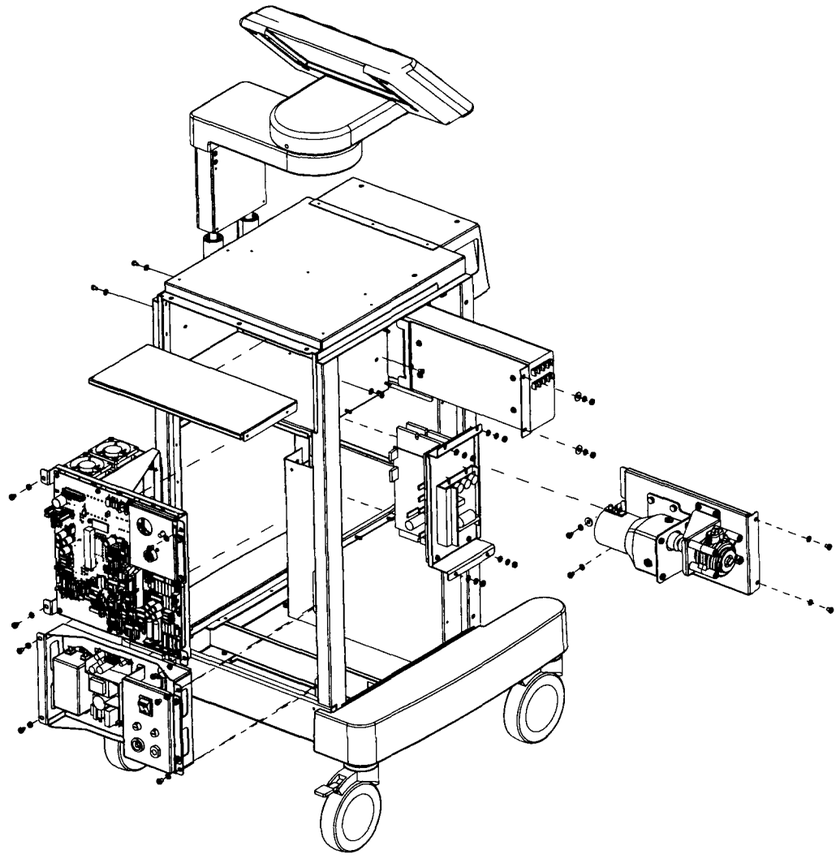


Schematic 3. *Console interior, rear and left side*

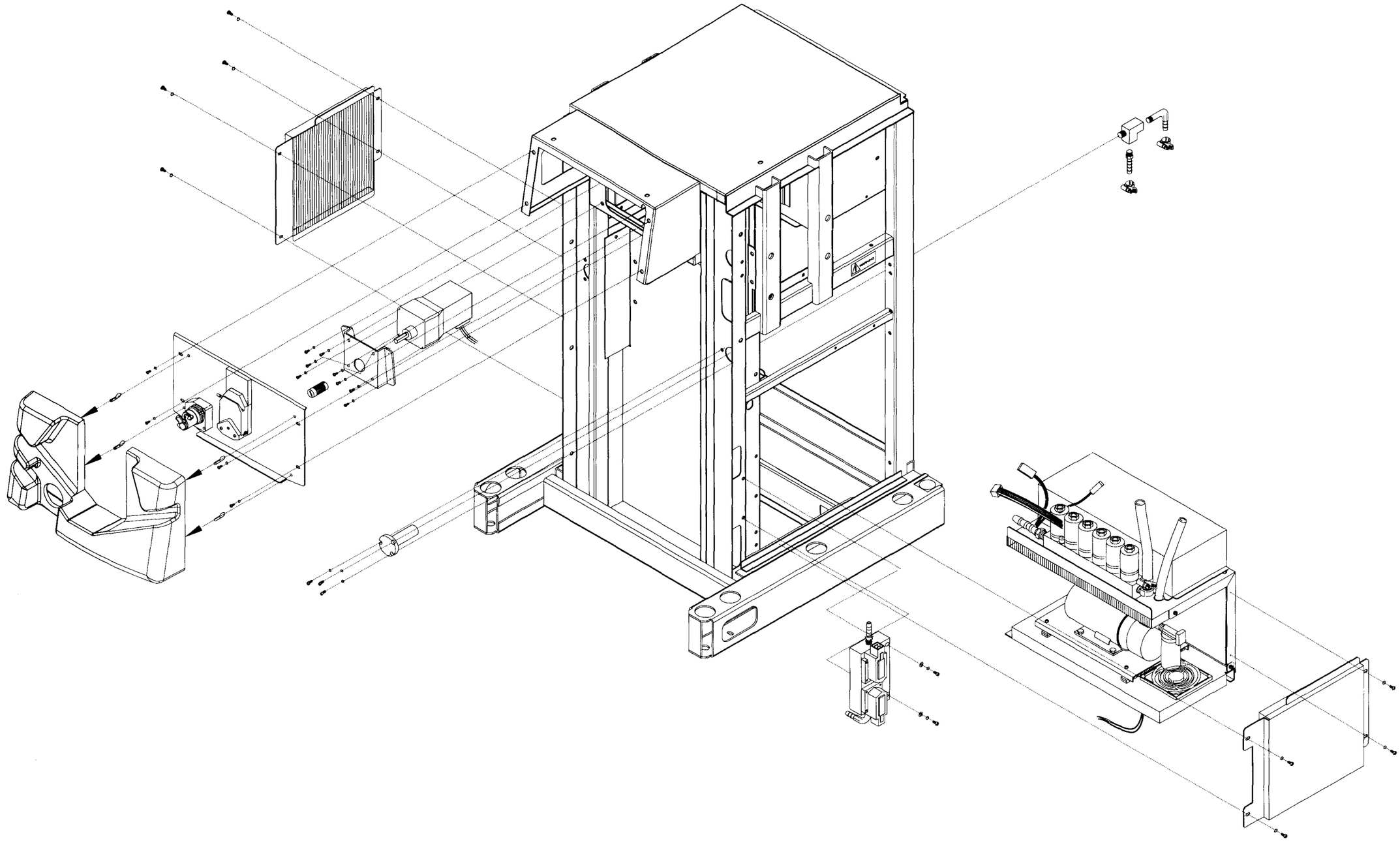


HP CONNECTOR DETAIL

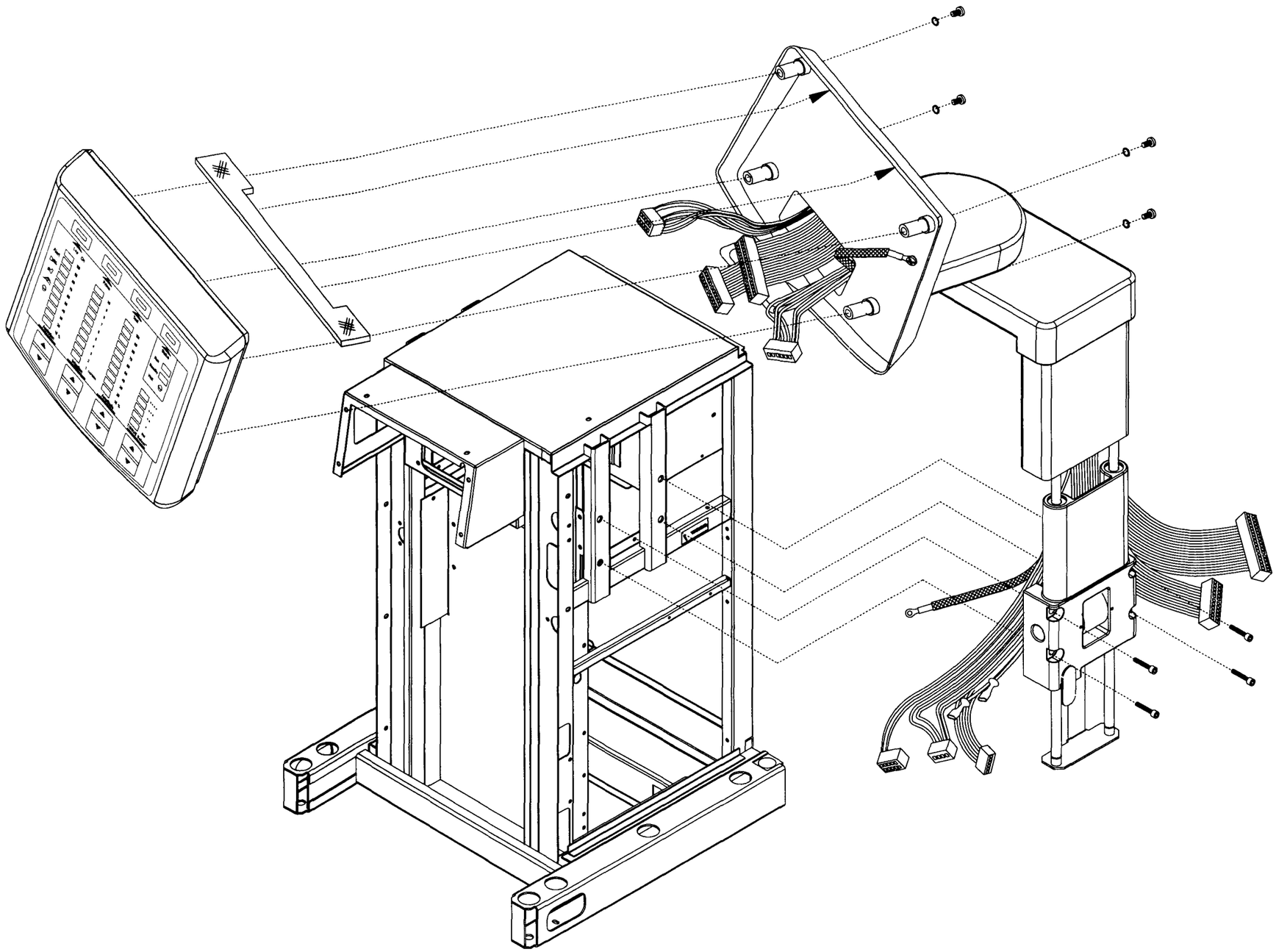




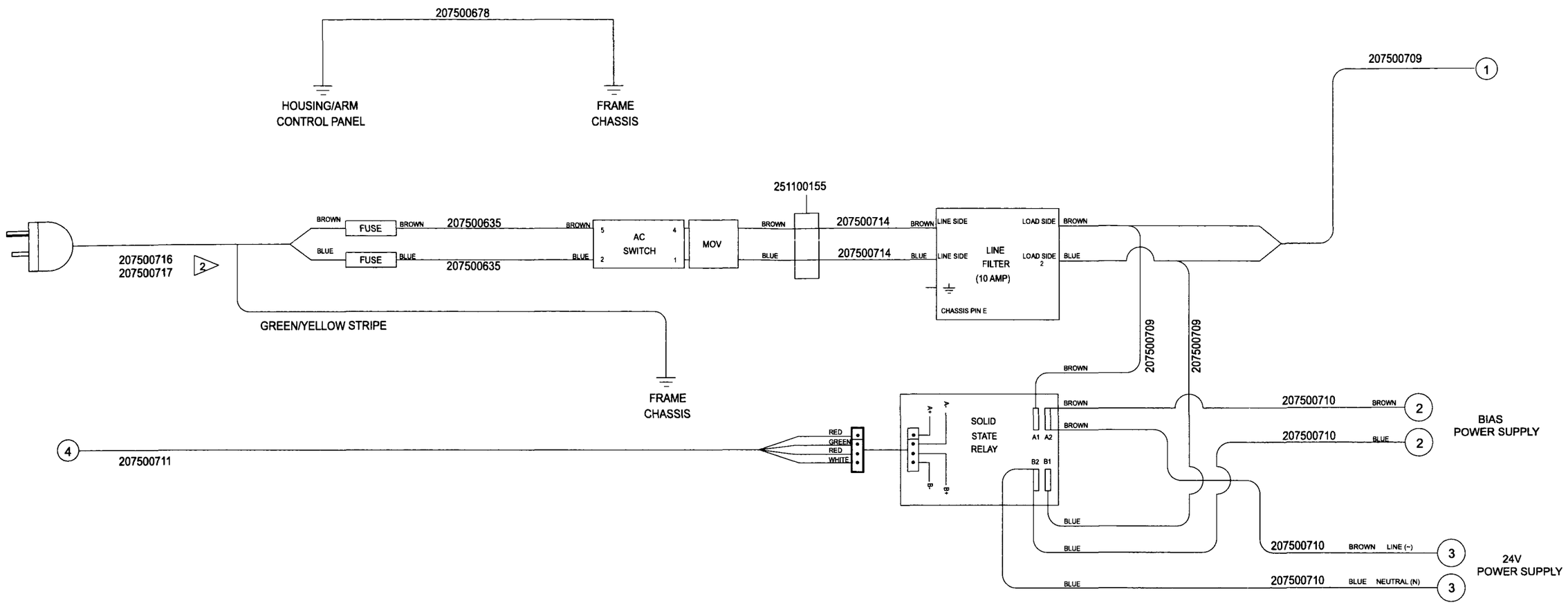
Schematic 4. *Console miscellaneous subsystems*



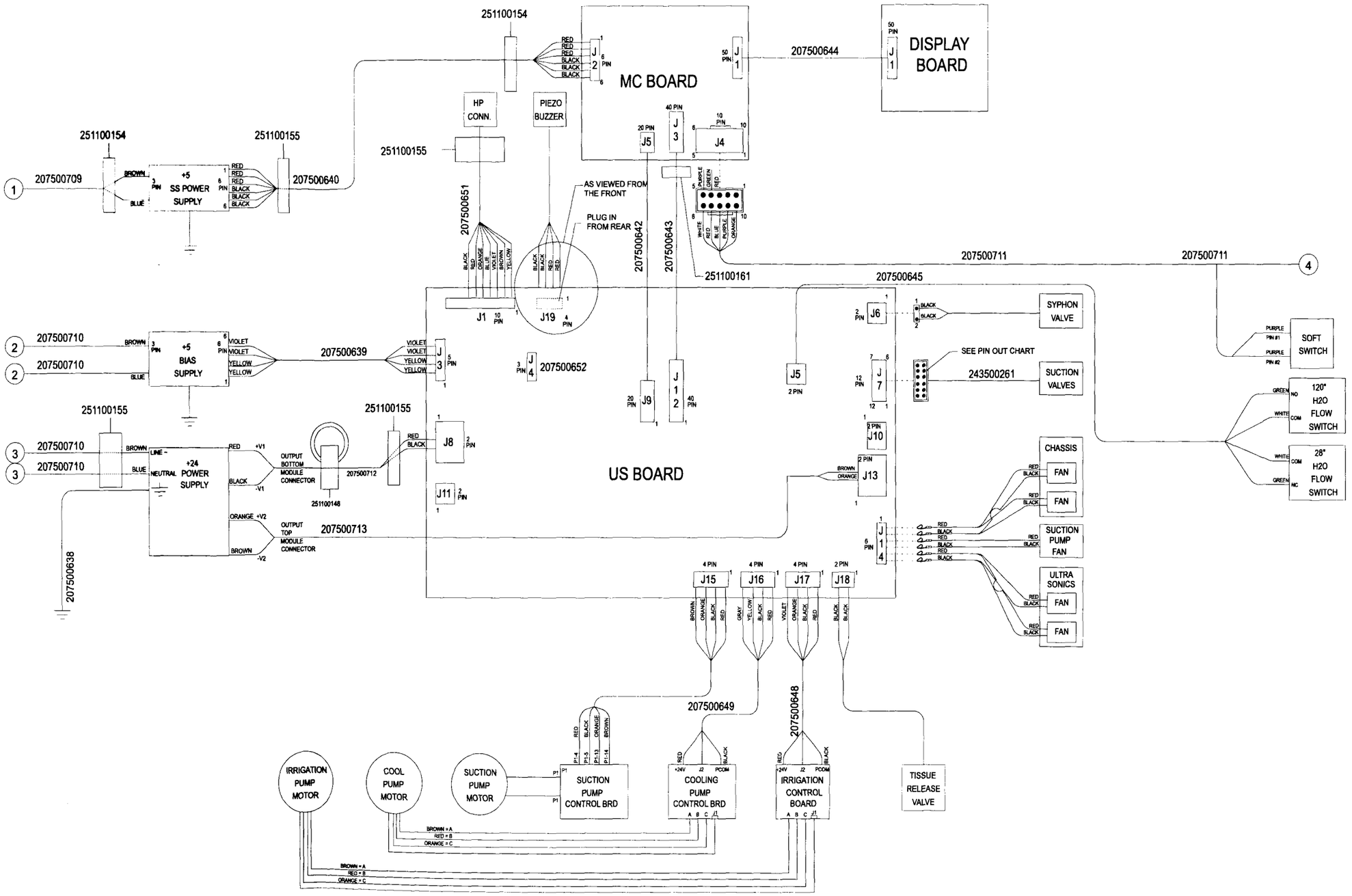
Schematic 5. *Subsystems relating to suction and irrigation*



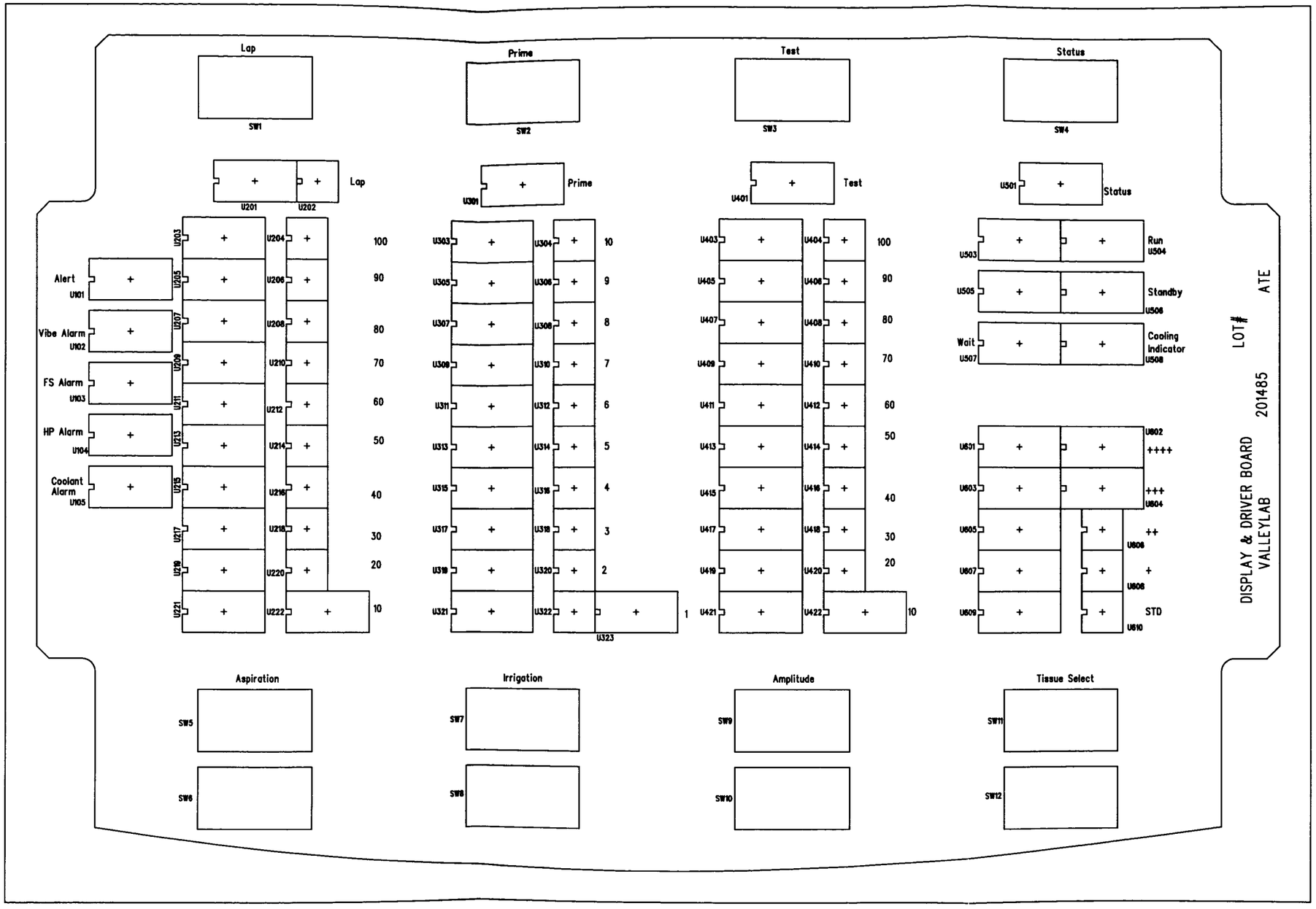
Schematic 6. *Arm and control panel assembly*



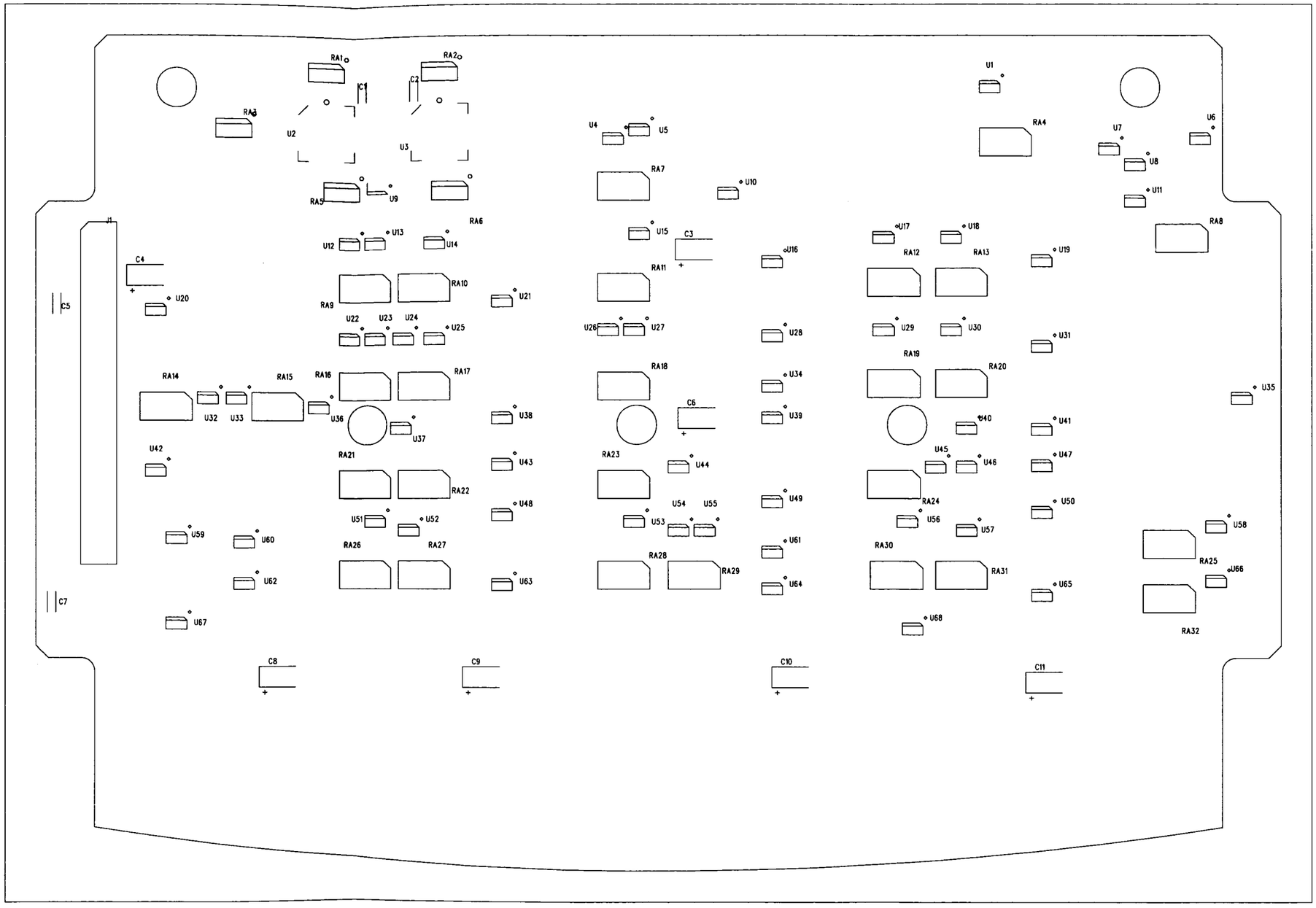
Schematic 7. *Interconnect diagram, sheet 1 of 2*



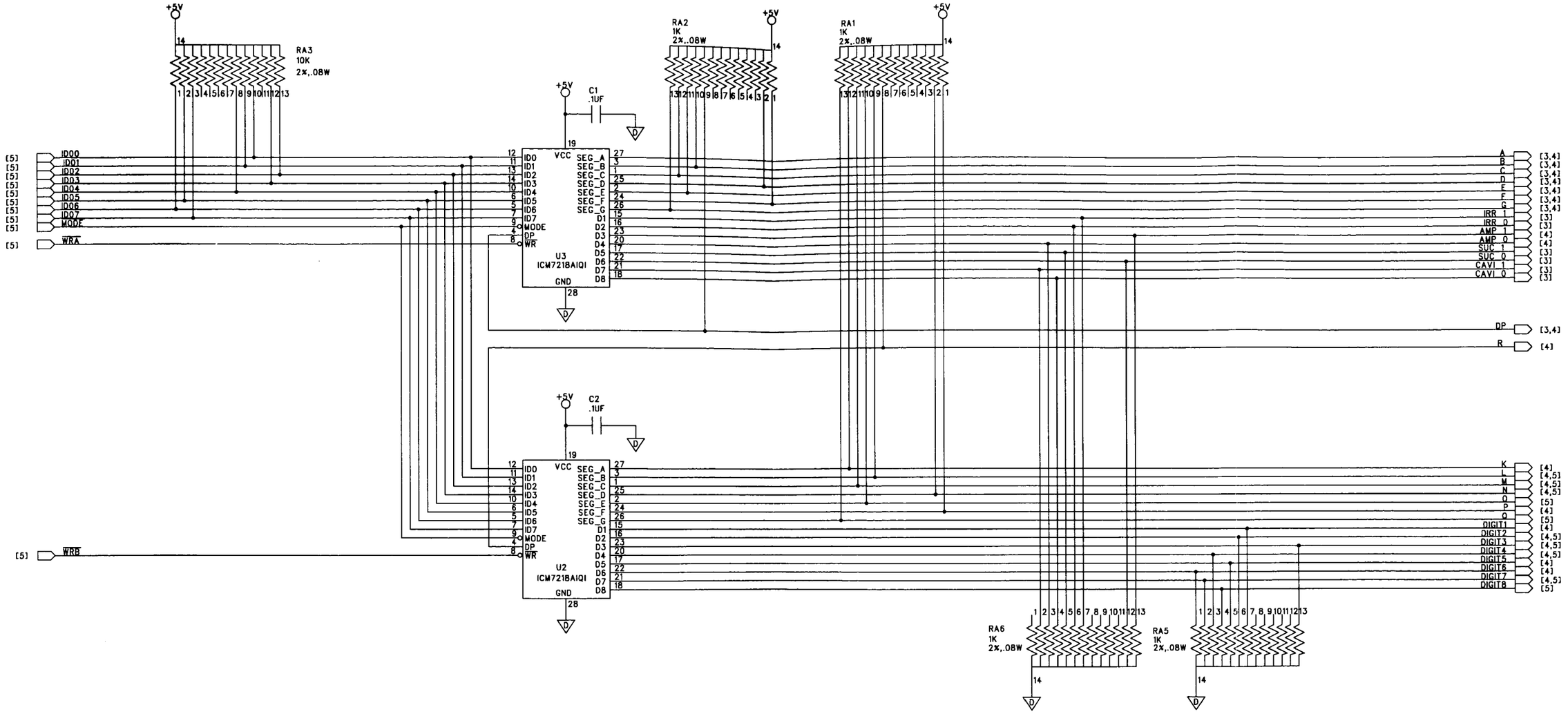
Schematic 8. *Interconnect diagram, sheet 2 of 2*



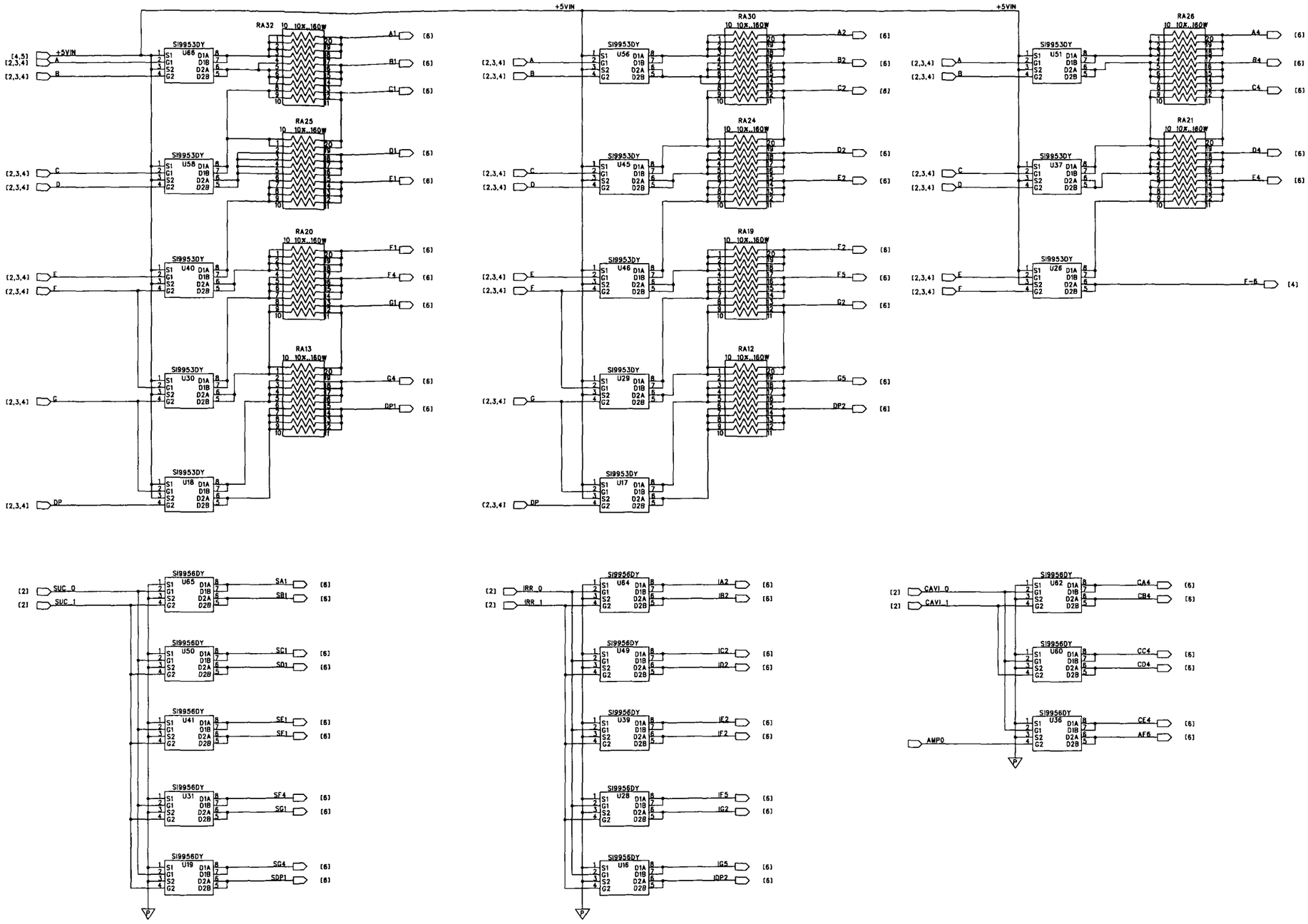
Schematic 9. *Display board layout, sheet 1 of 2*



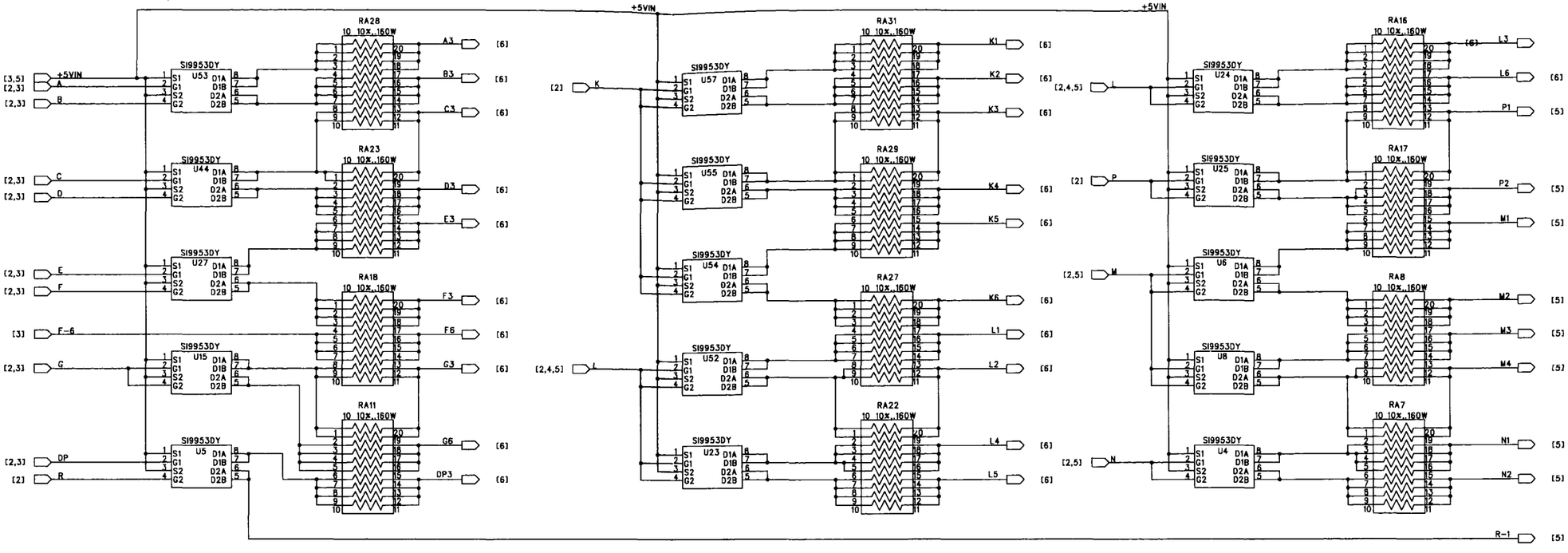
Schematic 10. *Display board layout, sheet 2 of 2*



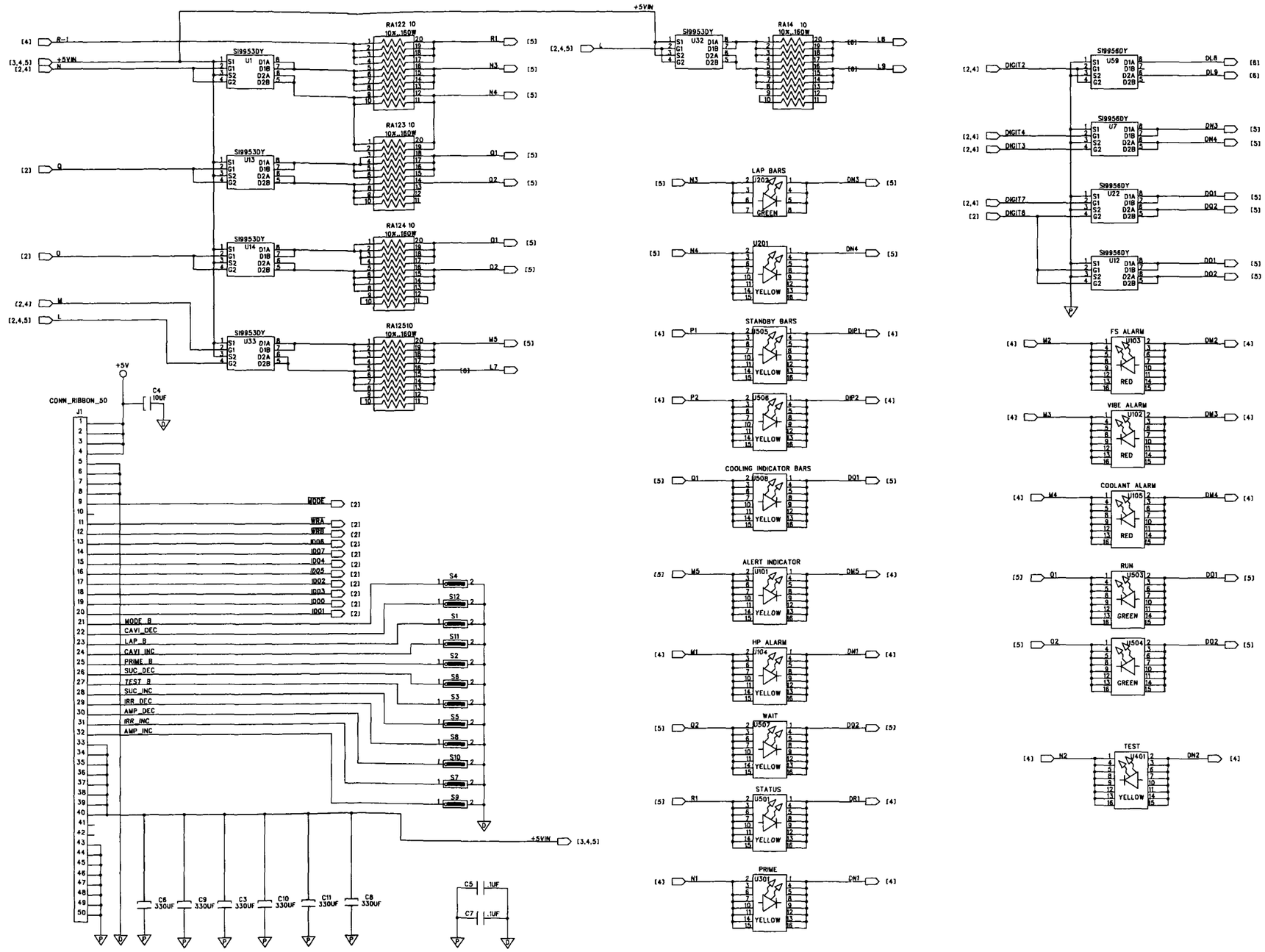
Schematic 11. *Display board schematic, sheet 2 of 6 (sheet 1 blank, thus not shown)*



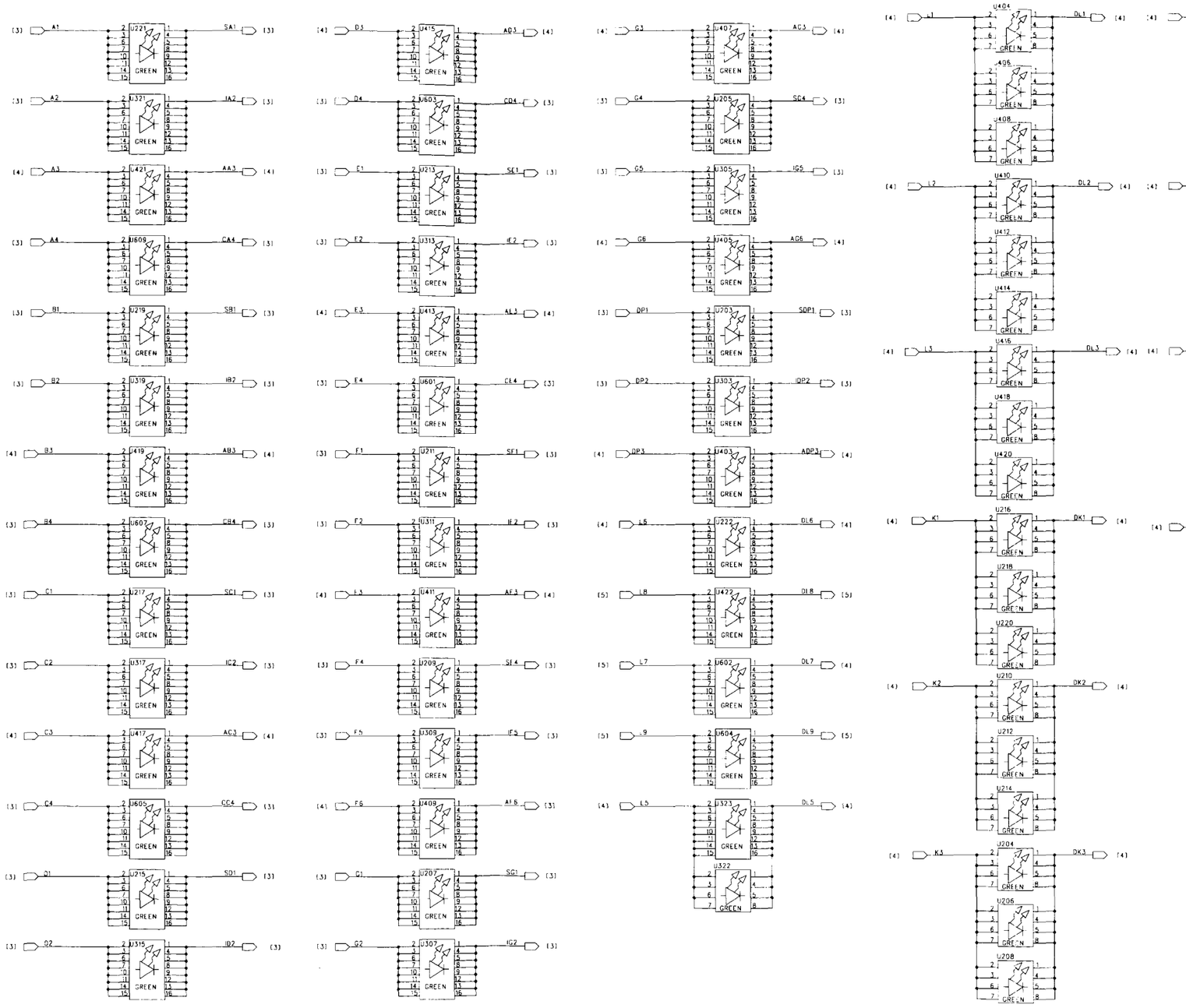
Schematic 12. *Display board schematic, sheet 3 of 6*



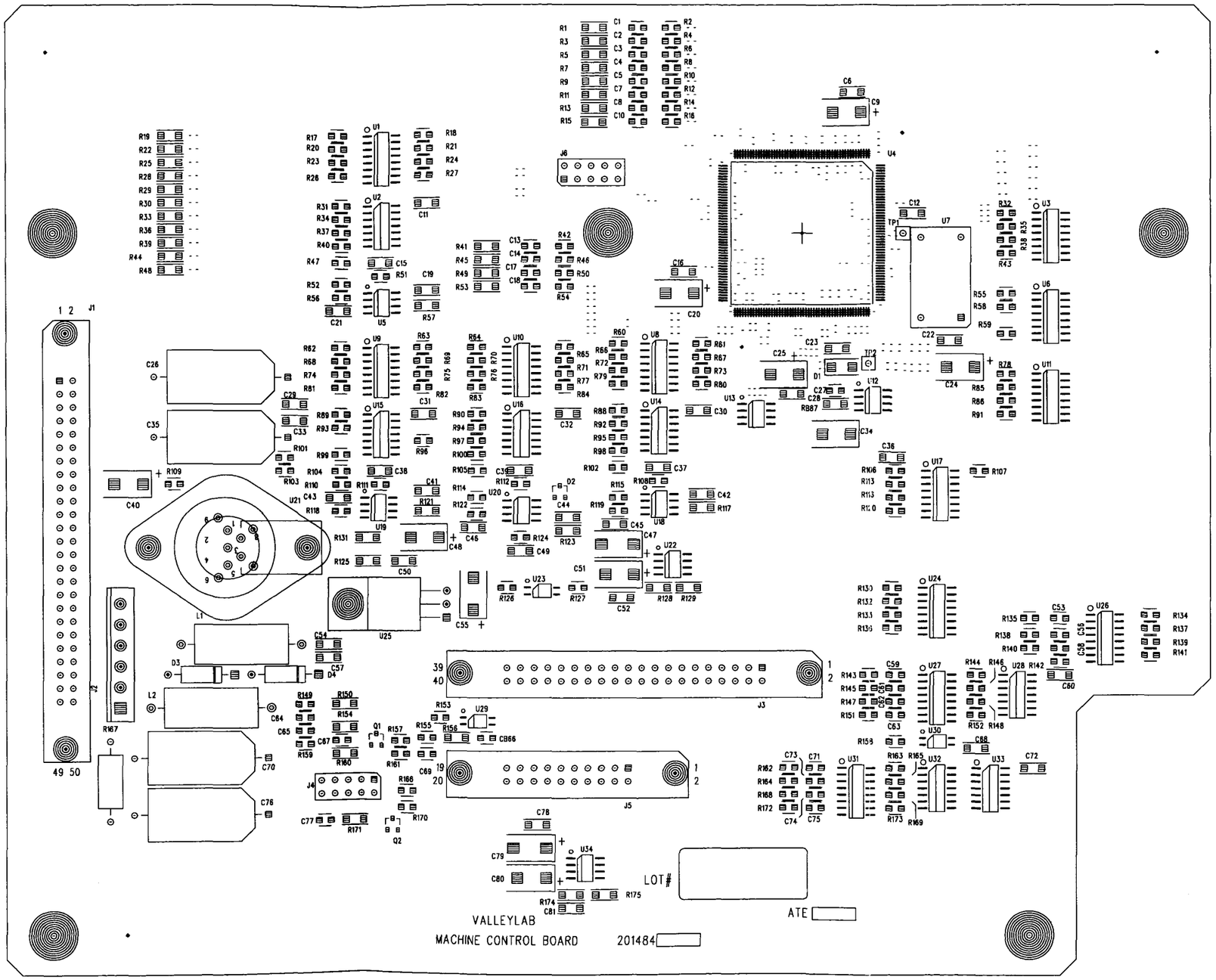
Schematic 13. *Display board schematic, sheet 4 of 6*



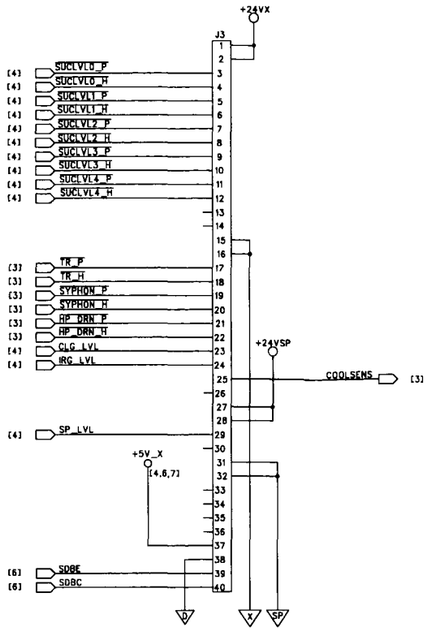
Schematic 14. *Display board schematic, sheet 5 of 6*

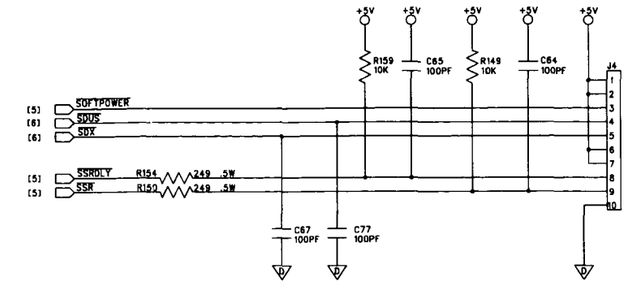


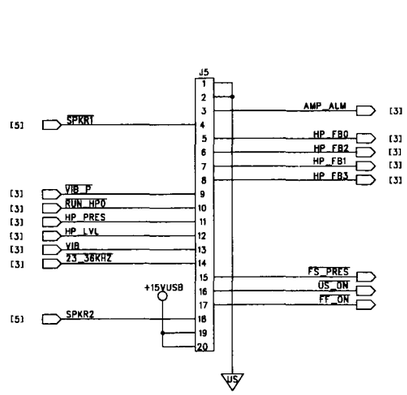
Schematic 15. *Display board schematic, sheet 6 of 6*

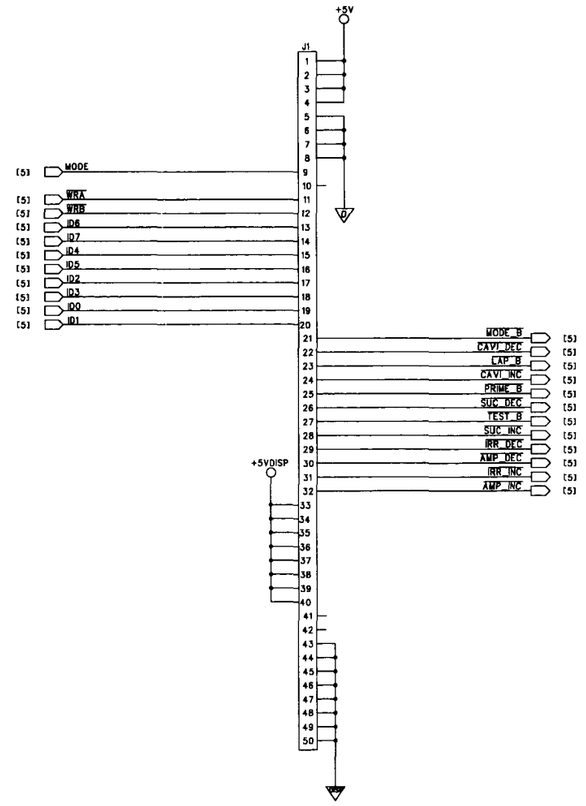


Schematic 16. *Machine control board layout, sheet 1 of 1*

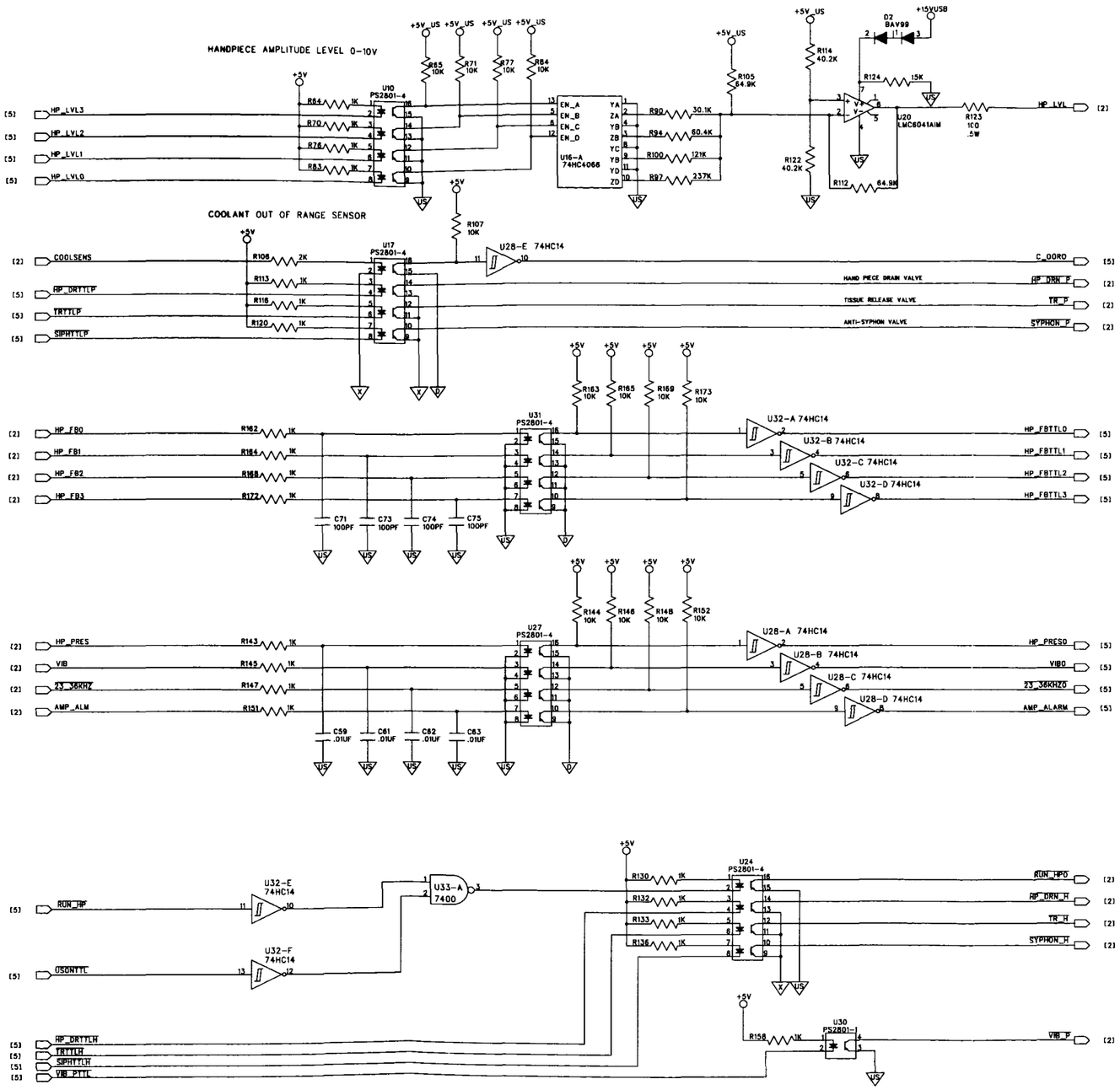




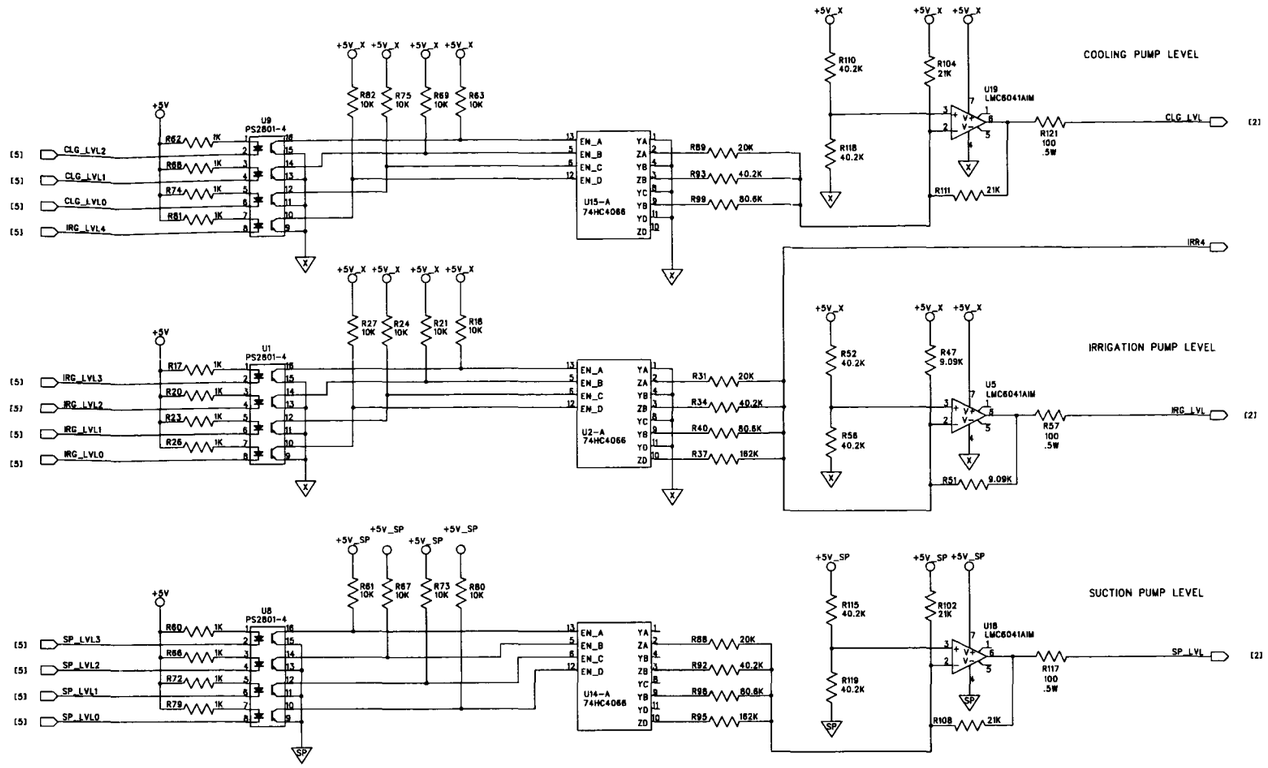




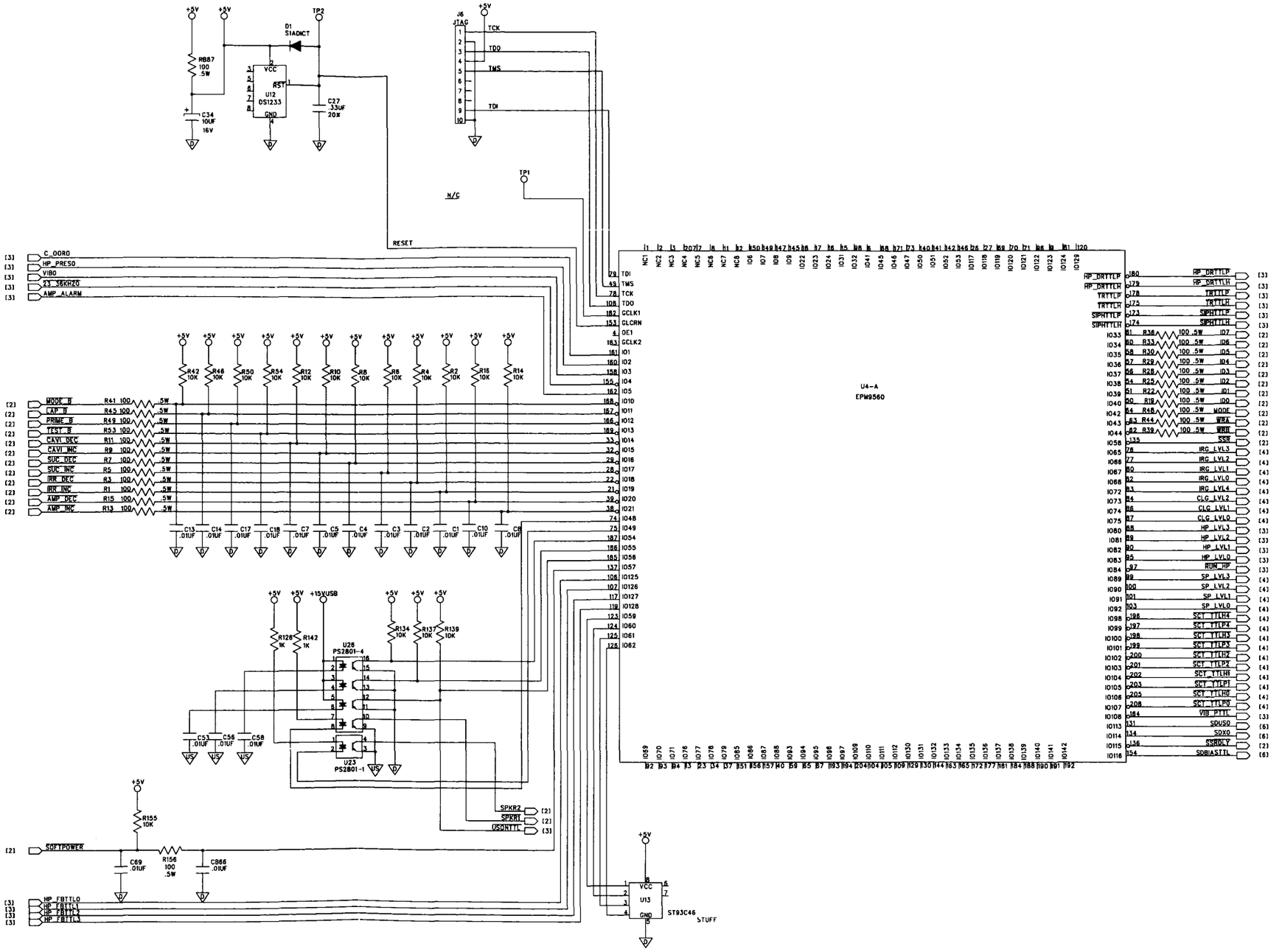
Schematic 17. *Machine control board schematic, sheet 1 of 6*



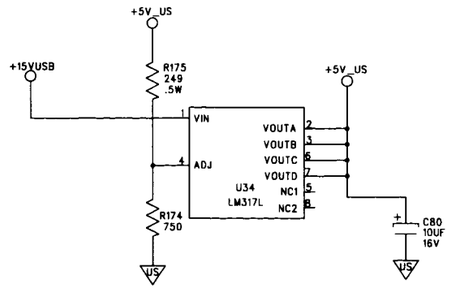
Schematic 18. *Machine control board schematic, sheet 2 of 6*

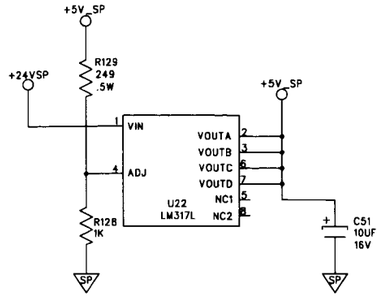


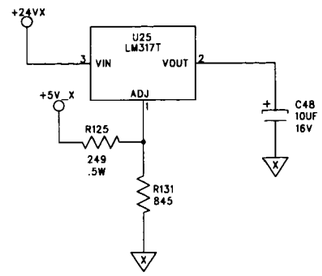
Schematic 19. *Machine control board schematic, sheet 3 of 6*

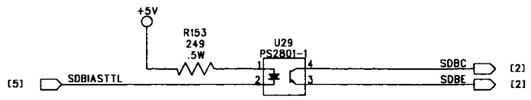


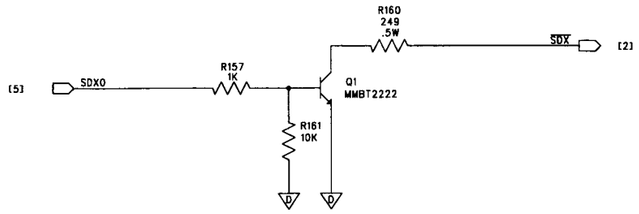
Schematic 20. *Machine control board schematic, sheet 4 of 6*

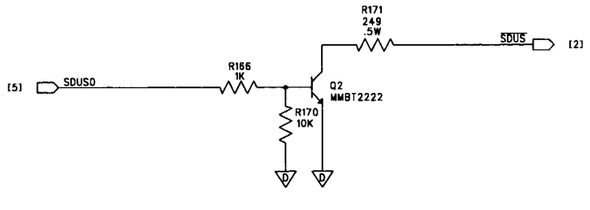


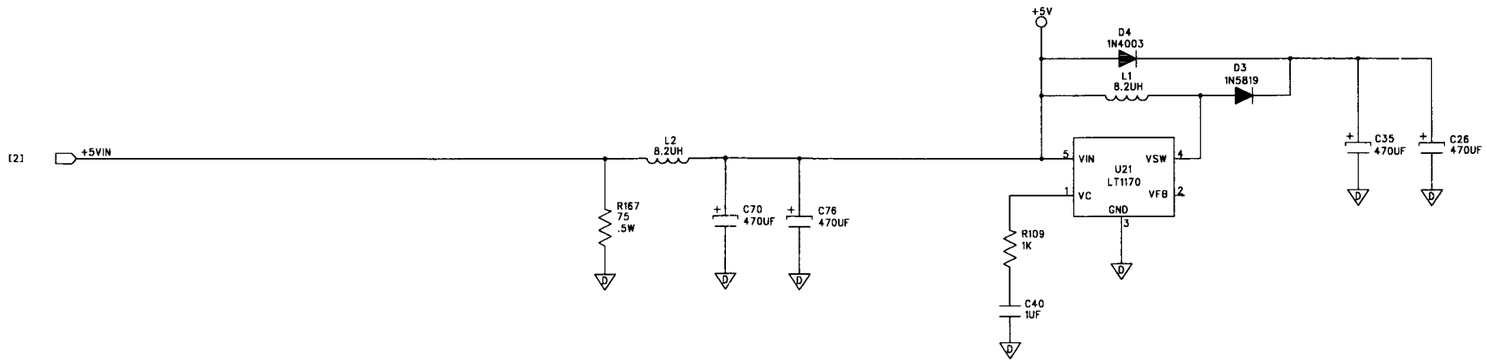






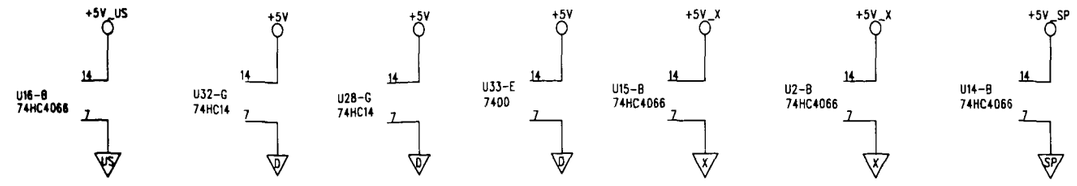


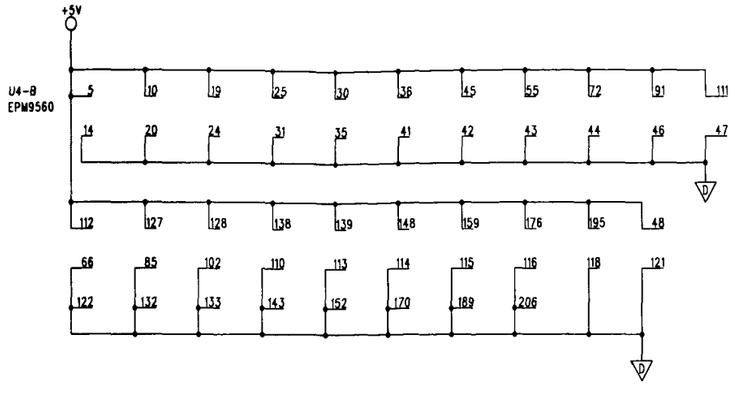




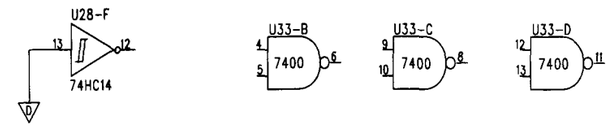
Schematic 21. *Machine control board schematic, sheet 5 of 6*

POWER
BYPASS CAPS

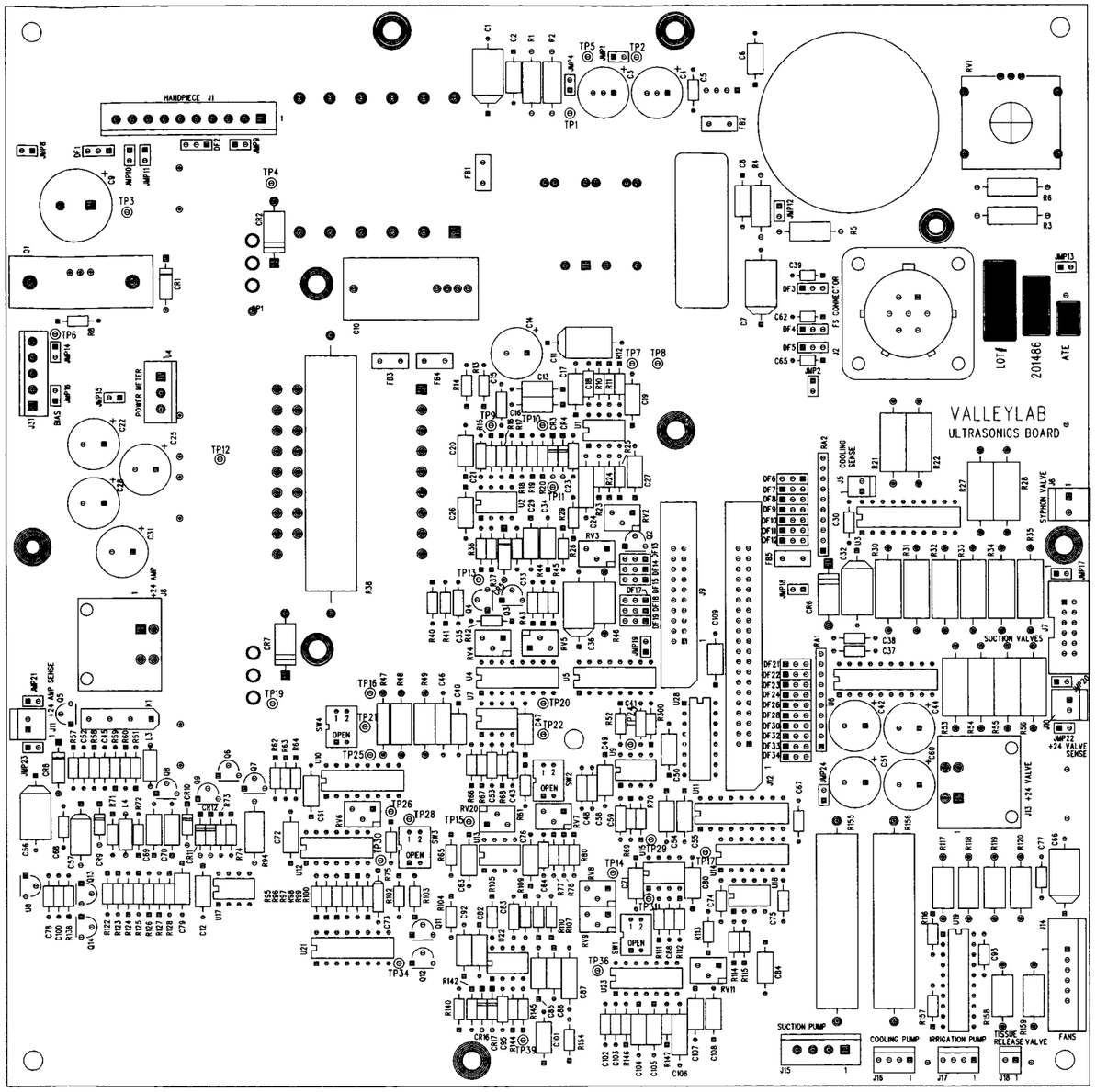




SPARES

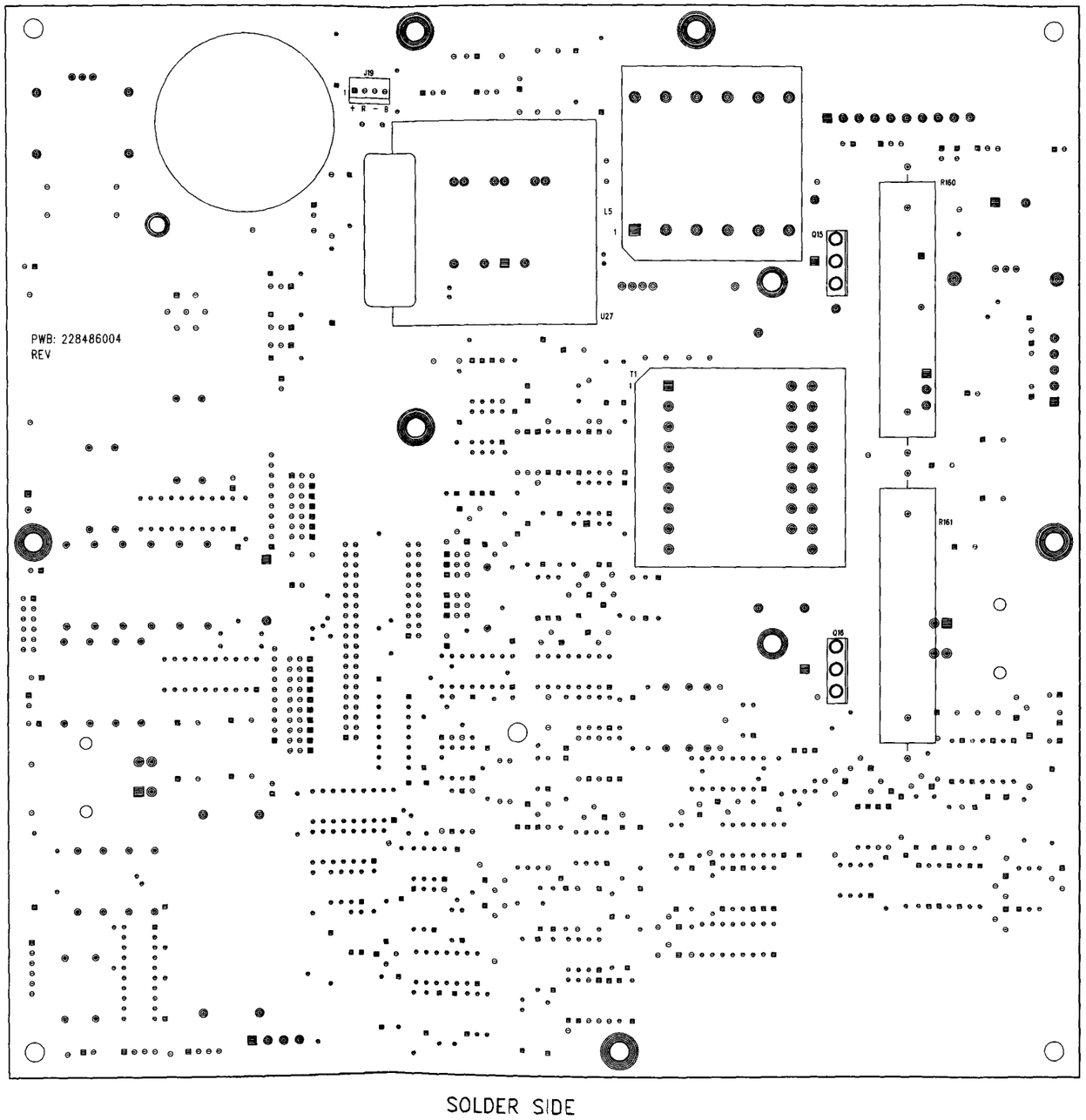


Schematic 22. *Machine control board schematic, sheet 6 of 6*

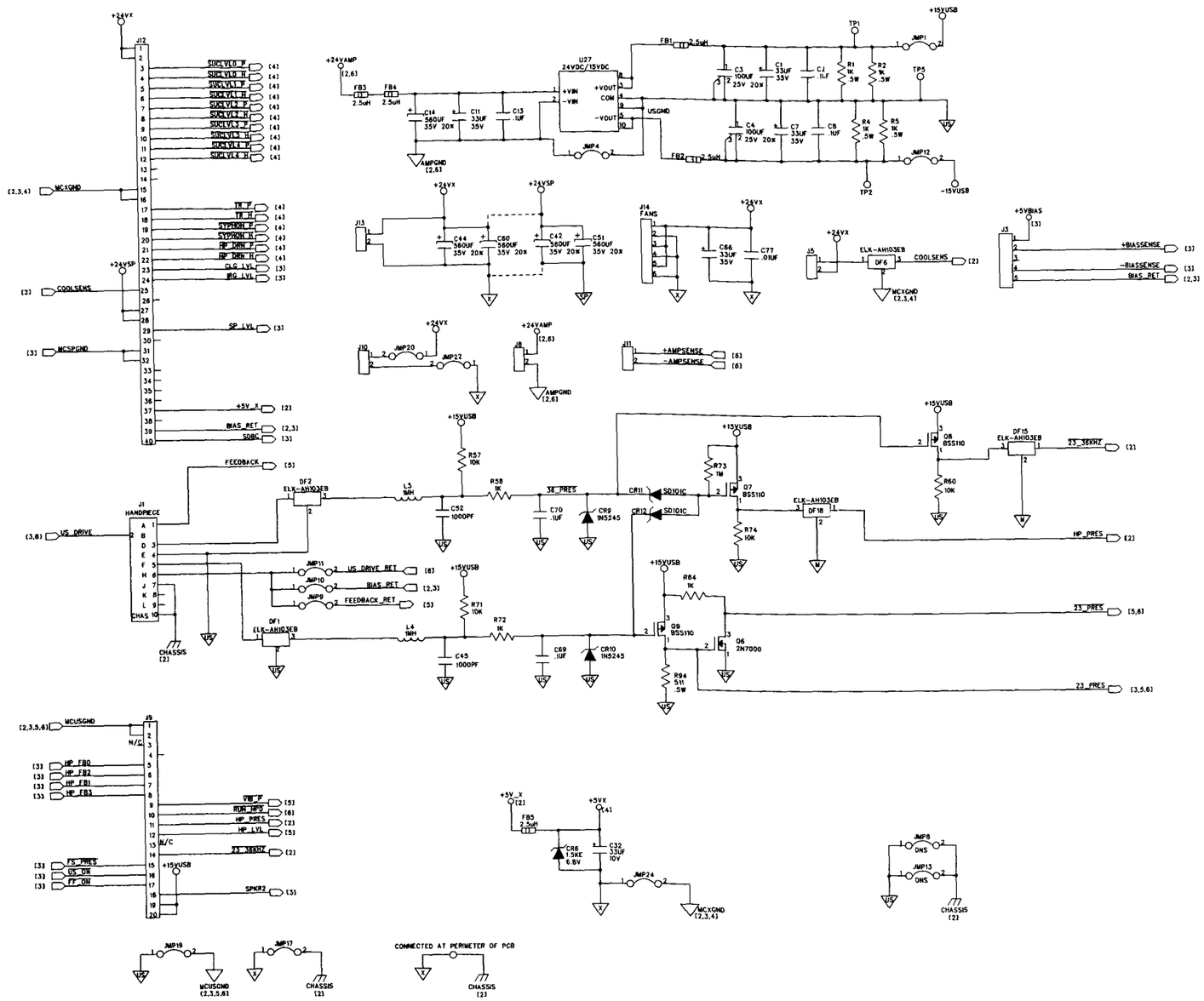


COMPONENT SIDE

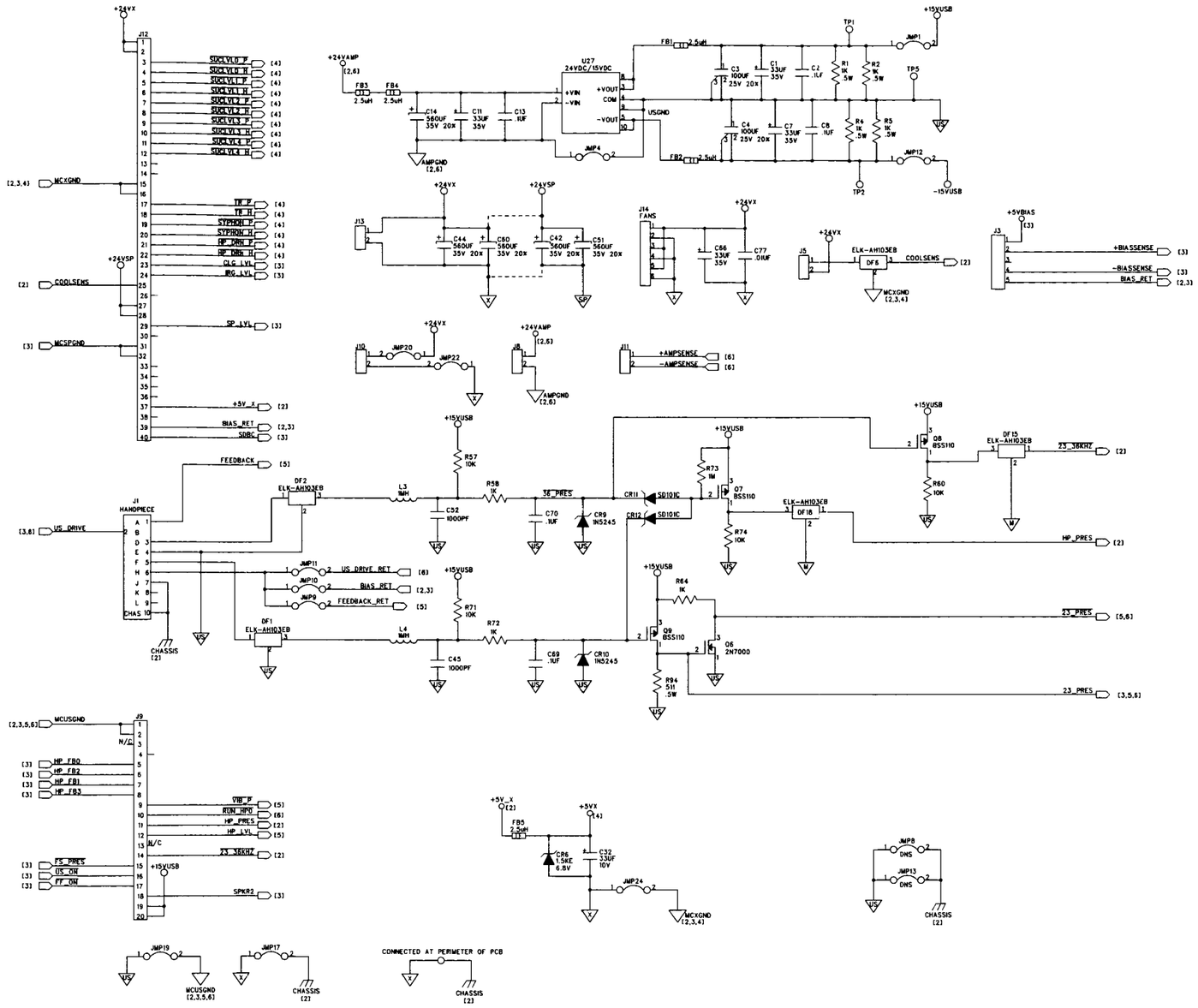
Schematic 23. *Ultrasonics board layout, sheet 1 of 2*



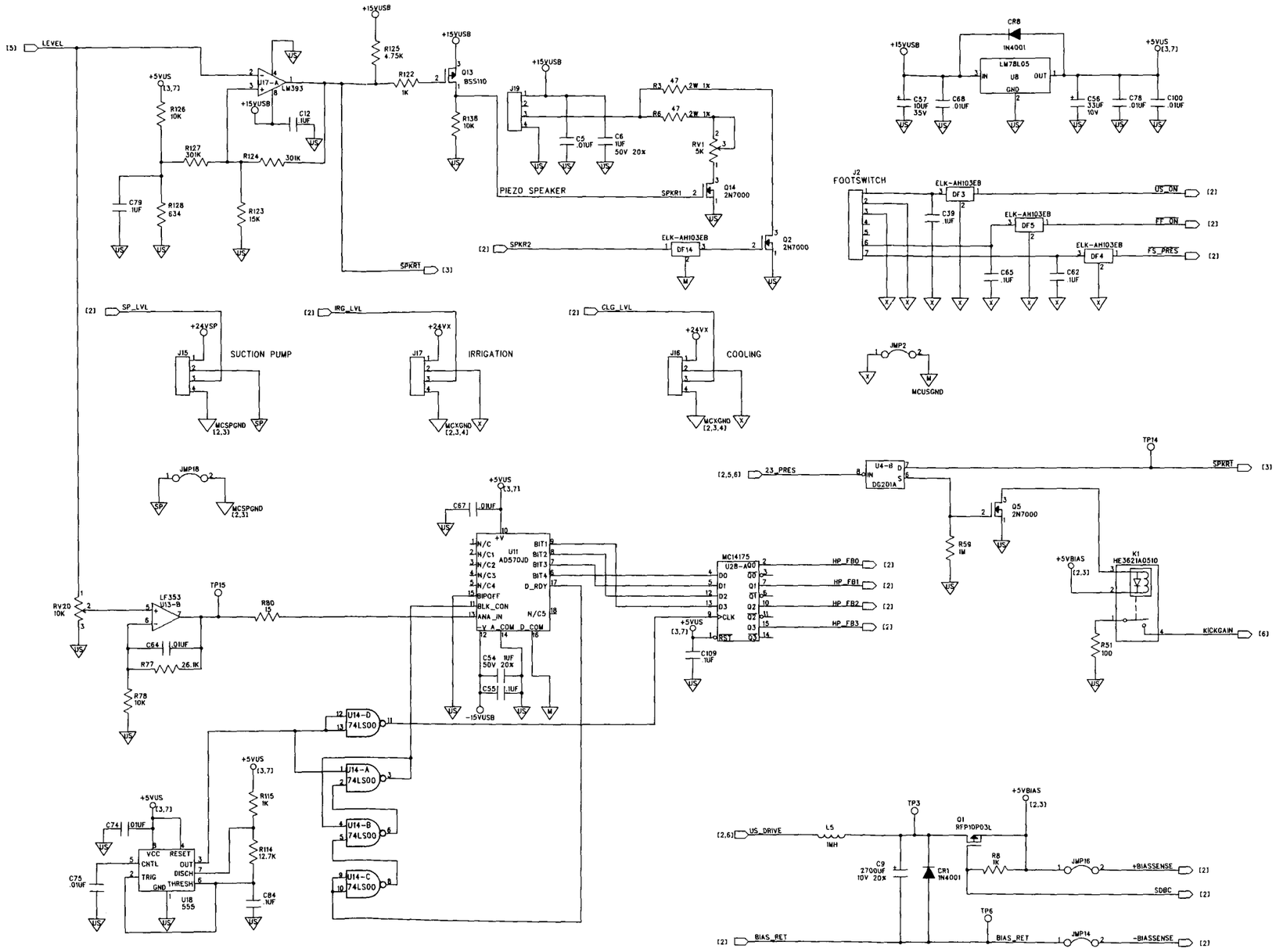
Schematic 24. *Ultrasonics board layout, sheet 2 of 2*



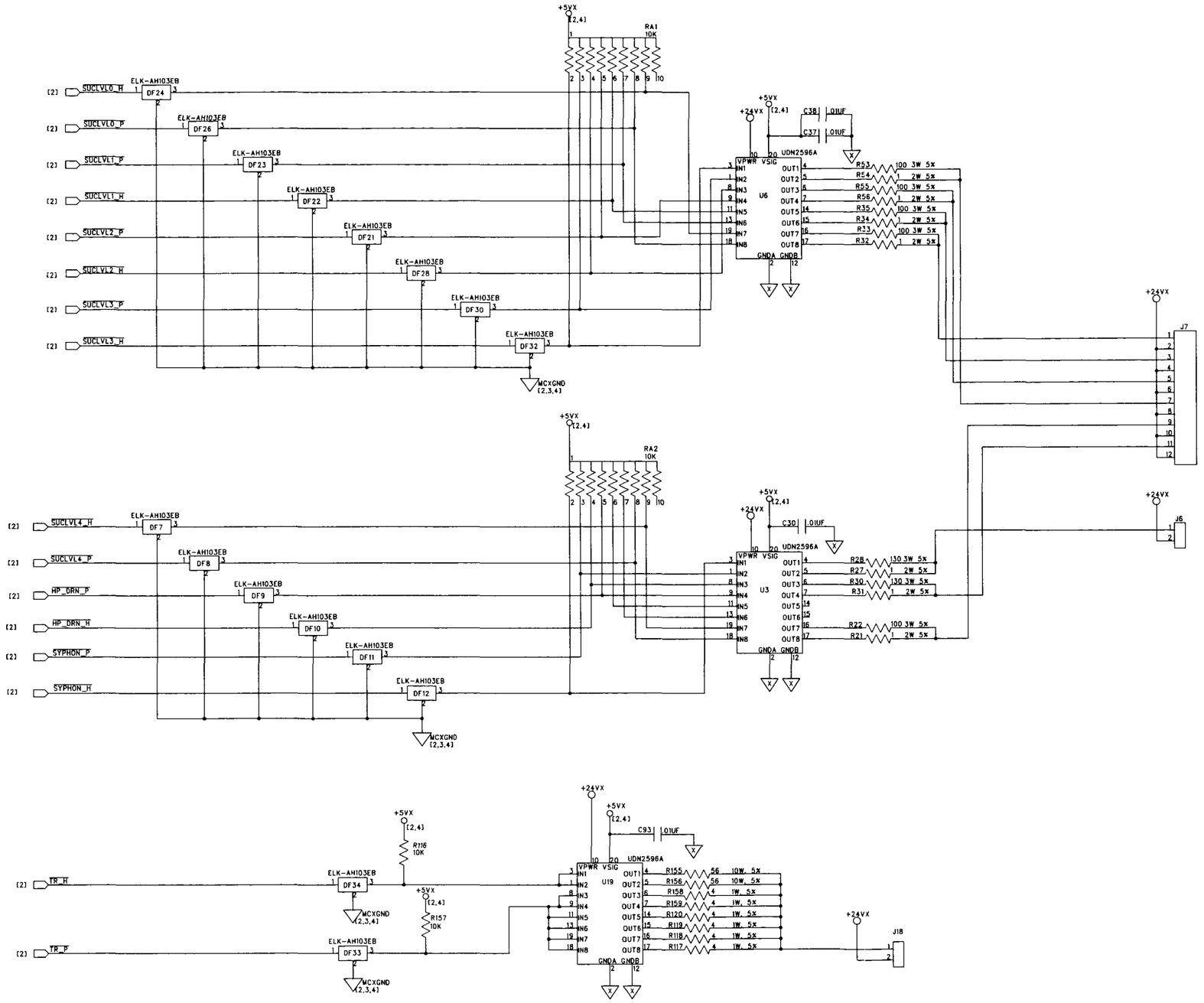
Schematic 25. *Ultrasonics board schematic, sheet 2 of 7 (sheet 1 blank, thus not shown)*



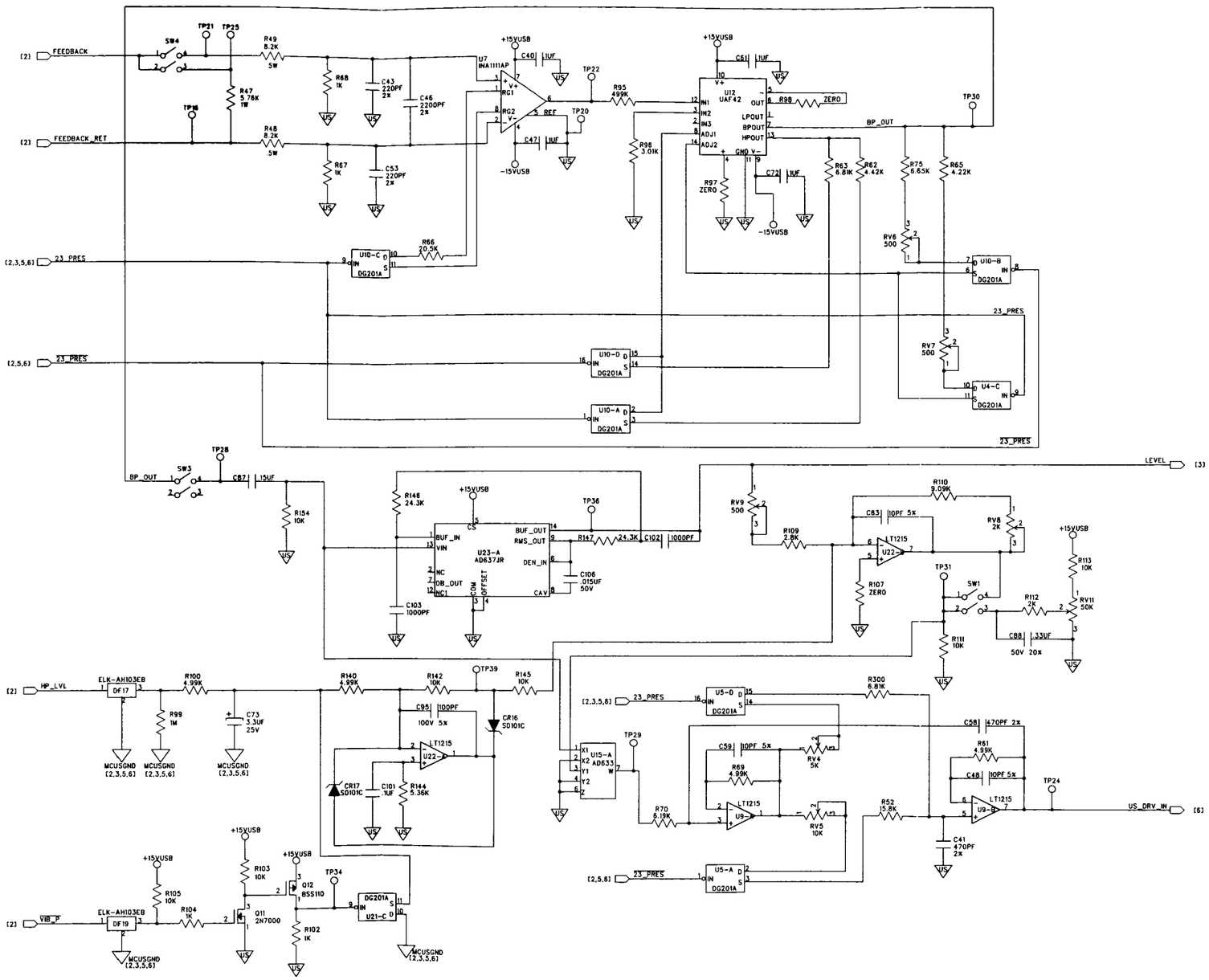
Schematic 25. *Ultrasonics board schematic, sheet 2 of 7 (sheet 1 blank, thus not shown)*



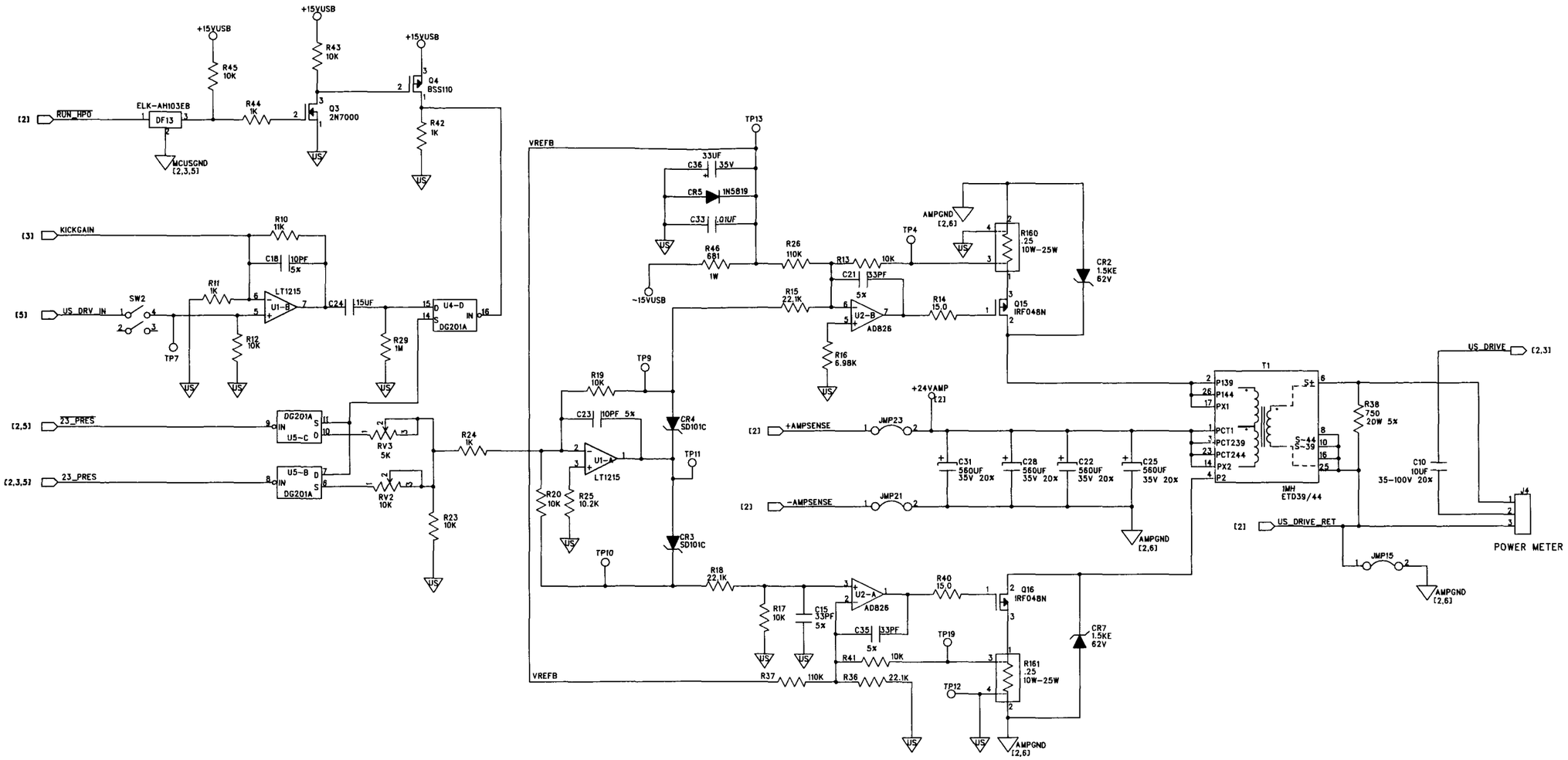
Schematic 26. *Ultrasonics board schematic, sheet 3 of 7*



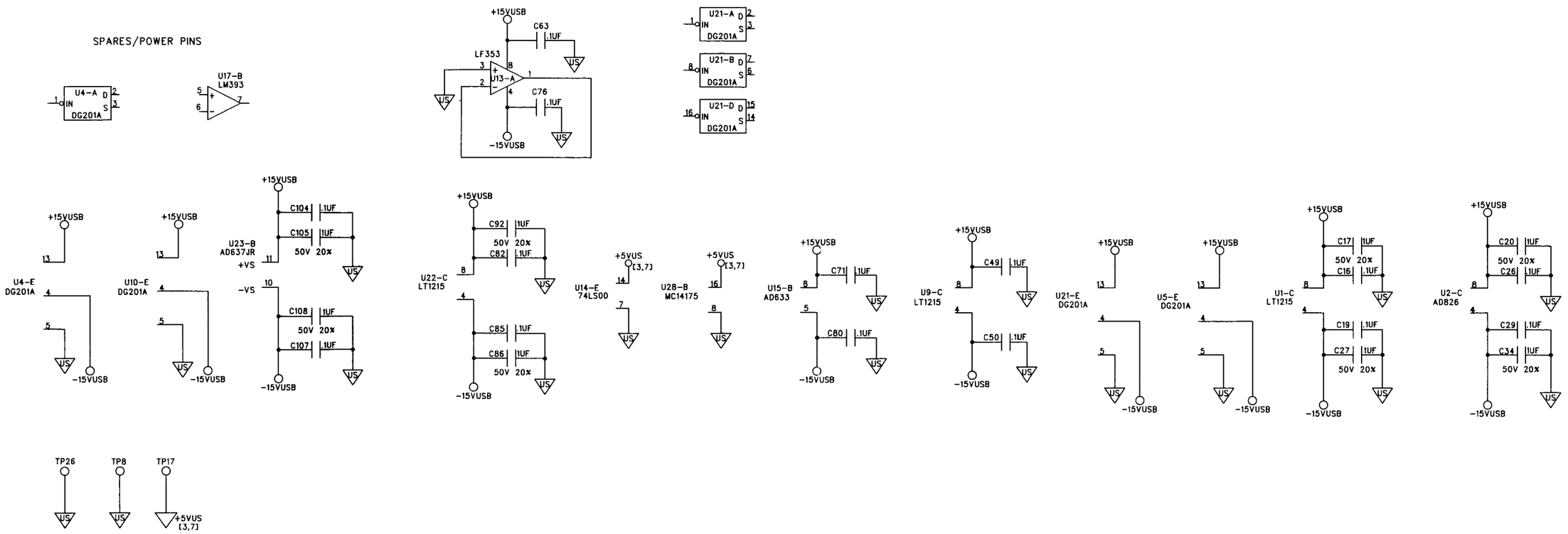
Schematic 27. *Ultrasonics board schematic, sheet 4 of 7*



Schematic 28. *Ultrasonics board schematic, sheet 5 of 7*



Schematic 29. *Ultrasonics board schematic, sheet 6 of 7*



Schematic 30. *Ultrasonics board schematic, sheet 7 of 7*